이학석사 학위논문

한국과 중국 하구 모래갯벌에서의 해양저서 규조류 다양성

Diversities of marine benthic Diatoms from estuarine sand flats in Korea and China

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초록

본 논문은 한국과 중국 하구의 모래갯벌에서 서식하는 저서 규조류를 관찰하고 동정한 결과를 보고하였다. 퇴적물 시료는 각각 2018년 8월과 10월에 중국과 한국에서 채취하였고, 실험실에서 퇴적물과 규조류를 분리하였다. 분리한 규조류는 다량의 유기물을 포함하고 있어, 이를 제거하기 위해 염산과 과산화수소를 사용하였다. 전처리가 끝난 규조류 시료는 영구 프레파라트로 제작하였다. 제작된 영구 프레파라트는 형광현미경으로, 전처리한 규조류 시료는 전자현미경을 사용하여 규조류를 관찰하고, 사진을 촬영하였다. 종 동정 결과 33과 58속 210종을 확인할 수 있었다. 속 수준에서 한국과 중국에서 가장 우점하는 속은 *Navicula*로 전체에서 20.33%를 차지하였다. 그 다음으로 *Amphora*, *Nitzschia* 순으로 나타났다.

KEY WORDS: Benthic diatom 저서 규조류; Korea 한국; China 중국; Sand flat 모래갯벌.

제 1 장 서 론

규조류(Diatom)는 황갈조문(Chrysophyta)의 돌말강(Bacillariophyceae)에 속하는 미세조류이다(Simonsen, 1979). 규조류는 서식 환경에 따라서 뻘이나 암반, 모래에 부착하여 서식하는 저서 규조류(Benthic diatom)와 수중에서 부유 생활하는 부유 규조류(Planktonic diatom)로 나뉜다(Round et al., 1990). Park (2004)에 따르면 저서 규조류는 다시 니질 퇴적물에 서식하는 epipelon, 사질 퇴적물에 서식하는 epipsammon, 암석의 표면에 부착하는 epilithon으로 구분하였다.

세계적으로 규조류 연구는 18할 것으로 보여 지는 중국의 경우 Jin et al. (1985, 1991)에 의해 중국 연안에서 출현하는세기 말부터 시작되어 현재에는 규조류의 분류 및 분포 뿐 만 아니라 이들의 광합성 생리 및 물질생산, 생태적인 역할에 대한 연구에 이르렀다. Park (2004)에 따르면 다양한 규조류 연구는 그 지역에 서식하는 규조류의 식물상에 대한 연구가 선행되어야 한다. 국내에서의 규조류 분류 연구 중 저서 규조류에 대해서는 심과 조 (1984)가 영종도 조간대 퇴적물, 조 (1988)가 낙동강 하구 퇴적물, Lee (1988)는 진해만에서, Park (2004)은 새만금에서 저서 규조류의 분포 및 종을 기재한 연구가 있다.

한국과 규조류 식물상이 비슷 저서 규조류를 자세히 기재, 도판으로 제시하였다.

저서 규조류의 식물상에 대한 연구의 관심도가 한국과 중국이 낮고, 한국과 중국 간의 식물상을 비교한 연구가 없다. 본 연구에서는 비슷한 위도를 가지는 한국과 중국의 하구 중 모래갯벌을 가지고 있는 한국의 낙동강과 중국의 푸투안 강을 조사지역으로 선정하였다. 각 출현 종의 기재는 최근 연구를 반영하면서 종의 특징을 상세히 서술하였다.

제 2 장 재료 및 방법

2.1 조사지역

본 연구의 조사지역은 비슷한 위도에 위치하며, 모래갯벌을 가진 한국의 낙동강 하구와 중국의 푸투안 하구이다.

낙동강은 한국의 경상도 지역을 걸쳐 남해로 흐르는 큰 강이다. 낙동강의 하천연장은 400.7km, 유역면적은 2만 3384.21km^{2}에 이른다. 낙동강은 상류 지점인 안동과 하구 사이의 하상고도가 100m도 되지 않는 완만한 경사를 가지고 있어서 하구에 삼각주가 발달했을 뿐만 아니라, 바다와 만나는 지점에서는 백합등과 같은 모래섬이 형성되었다. 낙동강 하구의 샘플 채취는 2018년 10월에 모래섬인 백합등(35° 03′ 53.3″ N, 128° 56′ 21.9″ E)에서 정점 2곳(BH 1, BH 2)을 선정해서 채취하였다(Fig. 1).

푸투안강은 중국의 산둥성 남동부에 위치한 르자오시 남단을 걸쳐 황해로 흐르는 강이다. 푸투안강의 길이는 51.5km, 유역면적 1,060km^{2}에 이른다(Song et al., 2017). 르자오시의 연안 형태는 주로 평편한 모래 해안선으로, 길이가 168.5km에 이른다(Song et al., 2017). 푸투안 하구에서의 샘플 채취는 2018년 8월에 모래해변(35° 17′ 52.82″ N, 119° 26′ 53.66″ E)에서 정점 2곳(RZ 1, RZ 2)을 선정해서 채취하였다(Fig. 1).

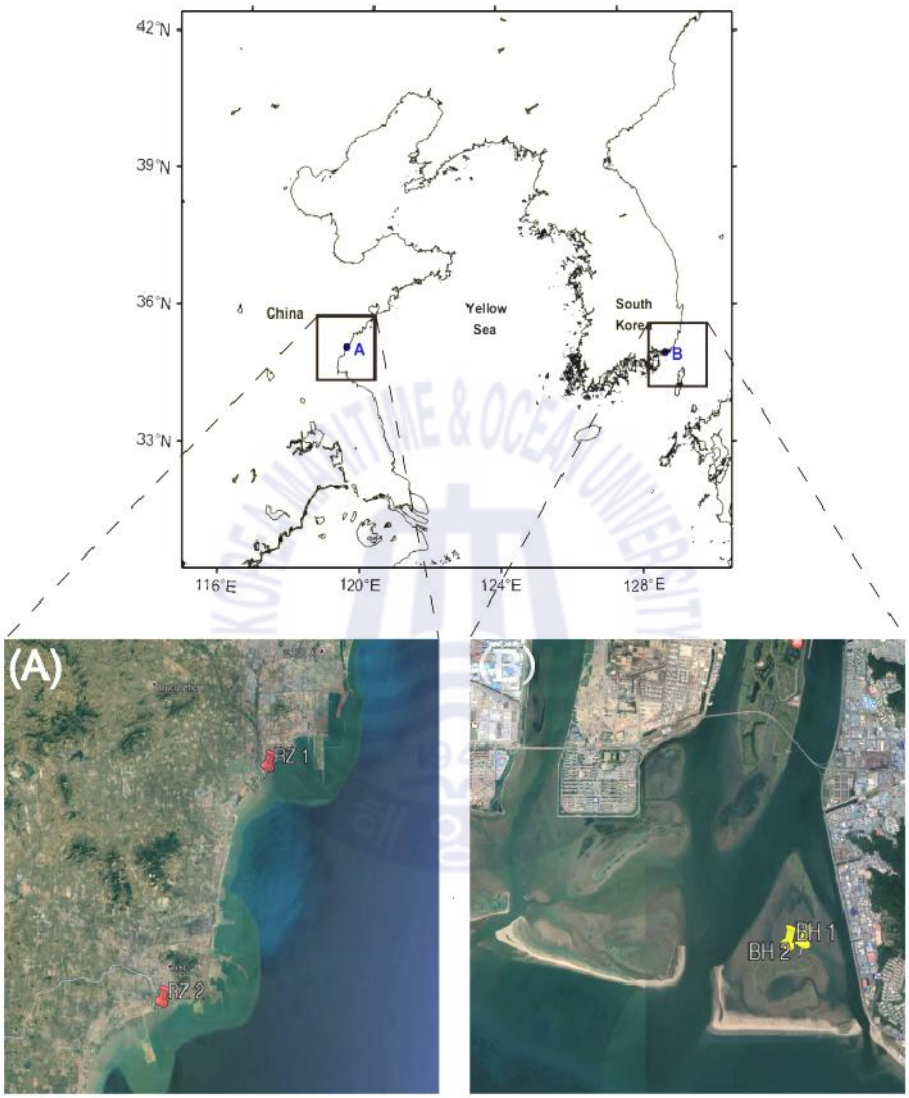

Fig 1. Study area

(A) : China futuan river estuary sand flat;

(B) : Korea Naktong river estuary sand flat

2.2 시료 채집 및 처리

2.2.1 시료 채집

퇴적물 시료는 퇴적물의 표층(0-0.5 cm)을 스파툴라(spatula)로 긁어서 채집하였다. 채집한 시료는 50 ml 코니컬 튜브(conical tube)에 담아 현장에서 해수와 포르말린을 섞어 7 % 포르말린으로 고정한 후, 실험실로 가져왔다. 포르말린으로 고정한 시료는 박 (2011)의 방법에 따라서, 퇴적물과 규조류를 분리하고, 염산(HCl)과 과산화수소(H_2O_2)를 이용해서 클리닝(cleaning) 과정을 진행하였다. 클리닝 과정이 끝난 시료로 영구 프레파라트를 제작하였고, 자세한 방법은 아래와 같다.

2.2.2 시료 처리

퇴적물에서의 규조류 분리

- 시료가 담긴 50 ml 코니컬 튜브(Conical tube)에 증류수를 넣어 40 ml로 맞추고, 시료가 잘 섞이게 흔들어 준다.
- 잘 섞인 시료의 일부(약 20 ml)를 다른 50 ml 코니컬 튜브에 옮겨 담는다.
- 옮겨 담은 시료는 다시 증류수를 넣어 40 ml에 맞추고, 5초간 초음파 처리(sonication) 한다.
- 초음파 처리 후 5초 뒤에 상등액만 100 ml 비이커에 옮긴다.
- 증류수를 넣어 40 ml에 맞추고 15초간 초음파 처리 후 5초 뒤에 상등액만 비이커로 옮긴다.
- 같은 방식으로 초음파 처리 시간을 30초, 45초, 1분으로 바꿔가며 상등액이 맑아질 때 까지 반복한다.

규조류 분리 후 탄산칼슘 제거

퇴적물에서 규조류를 분리했다고 하나, 상등액에는 규조류 외에도 여전히 많은 유기물질과 실트 입자를 함유하고 있다. 규조류 관찰 시 유기물질과 실트입

자에 대한 간섭을 최대한 줄이기 위해 이를 제거하기 위한 과정이 필요하다. 이 과정은 3일에 걸쳐 진행된다.

1. 1~2일

- 비이커에 먼지가 들어가지 않게 처리한 후 분리한 규조류 시료는 하루 동안 침전시킨다.
- 침전된 시료가 교란되지 않게 천천히 상등액을 따라 버리고, 증류수를 시료 부피 30 ml가 될 때 까지 첨가한다.
- 염산(HCl) 10 ml를 넣어, 시료 부피를 40 ml로 맞추고, 비이커를 핫플레이트(hot plate)로 옮겨, 150 ℃에서 2시간 동안 가열한다. 이 때, 시료가 완전히 마르지 않도록 주의해야 한다. 이 과정을 통해서 많은 양의 유기물질이 제거된다.
- 가열 2시간 후 핫플레이트를 끄고, 증류수를 부피가 100 ml가 될 때 까지 넣어준다. 이 때, 시료가 부유한다.
- 부유한 시료를 4시간 간격으로 침전시킨다. 침전된 시료가 교란되지 않게 상등액을 따라 버리고, 증류수를 채우는 과정을 4회 반복하여 염산을 중화 시킨다.

2. 2~3일

- 염산 중화 과정을 거친 시료는 부피 30 ml가 될 때까지 증류수를 넣어준다.
- 과산화수소(H_2O_2) 10 ml를 넣어, 시료 부피를 40 ml로 맞추고, 비이커를 핫플레이트로 옮겨 150 ℃에서 2시간 동안 가열한다. 시료가 완전히 마르지 않도록 중간에 증류수를 첨가해주고, 시료의 색깔이 하얗게 변하지 않을 경우에는 시료의 색깔이 하얗게 변할 때 까지 더 가열한다.
- 가열이 끝나면 핫플레이트를 끄고, 증류수로 부피가 100 ml가 될 때까지 넣어준다.
- 부유한 시료를 4시간 간격으로 침전시킨다. 침전된 시료가 교란되지 않게 상등액을 따라 버리고, 증류수를 채우는 과정을 4회 반복하여 과산화수소를 중화 시킨다.

2.3 현미경 관찰

클리닝된 규조류 시료는 상등액을 버리고, 시료를 scintillation vial에 옮겨 담는다. 규조류 시료는 현미경 관찰을 위해 영구 프레파라트로 제작하였다. 영구 프레파라트 제작은 다음과 같은 순서로 제작하였다.

1. 커버글라스를 50 ℃로 설정한 핫플레이트 위에 올려둔다.
2. 가열된 커버글라스에 알코올을 떨어뜨리고, 그 위에 시료를 일정량 떨어뜨린다.
3. 알코올이 마르기 전에 커버글라스의 시료가 고르게 퍼지도록 알코올을 소량 더 떨어뜨린다.
4. 시료가 완전히 마를 때 까지 핫플레이트에서 커버글라스를 가열한다.
5. 핫플레이트를 80 ℃로 설정하고 슬라이드 글라스에 레진(Naphrax)을 한 방울 떨어뜨린다.
6. 레진이 끓기 시작하면 시료가 완전히 마른 커버글라스를 슬라이드 글라스 위에 붙인다. 이 과정에서 커버 글라스와 슬라이드 글라스 사이에 기포가 발생할 수 있다. 이 기포를 제거를 해야 현미경으로 규조류를 관찰할 때 기포에 의한 간섭을 줄일 수 있다.
7. 기포를 모두 제거한 프레파라트는 상온에서 레진을 완전히 굳힌다.

영구 프레파라트는 Olympus BX53 형광현미경을 이용해 관찰했고, 관찰한 규조류의 형태를 촬영하기 위해서 현미경에 OLYMPUS Tech X Cam Ⅲ, ZEISS Axiocam 305 color 카메라를 부착하였다. 촬영한 규조류 사진은 Adobe Photoshop elements 10 프로그램을 이용해 도판을 작업했다. 그리고 좀 더 자세한 종 동정을 위해 전계방사형 주사전자현미경(Field Emission Scanning Electron Microscope) Tescan MIR-3를 이용해서 촬영했다.

정점 당 규조류 개체는 300개체를 계수하여 촬영했다.

제 3 장 결과 및 토의

3.1 환경 특성

두 조사 지역 간의 환경적인 변화를 알기 위해, pH, 수온(Tem, ℃), 용존산소(DO, mg/L), 염분과 니질 함량(Mud contents, %)을 측정하였다. pH, 수온, 용존산소, 염분은 휴대용 YSI를 사용해 측정하였고, 니질 함량은 Sieve 방법으로 측정하였다. 정점별 측정 결과는 Table 1에 정리하였다.

Table 1. Environmental parameters in each station.

Country	Station	pH	Tem. (℃)	DO (mg/L)	Salinity	Mud contents (%)
Korea	BH 1	7.90	11.48	10.07	20.94	3.2
	BH 2	7.88	11.26	10.12	20.23	4.0
China	RZ 1	7.73	31.30	4.88	13.83	24.7
	RZ 2	7.97	27.20	4.46	24.30	17.5

3.1.1 한국 낙동강 백합등

한국 낙동강 하구에서 pH는 7.88-7.90 범위였고, 수온은 11.26-11.48 ℃ 범위였다. DO의 경우 10.07-10.12 mg/L 범위였고, 염분은 20.23-20.94 범위였다. pH, 수온, DO, 염분의 경우의 정점 간 차이가 크지 않았다. 니질 함량은 4.0-3.2의 범위로, 해당 정점이 Sand가 우세한 퇴적환경인 것을 알 수 있었다.

3.1.2 중국 푸투안 하구

중국 푸투안 하구에서는 pH는 7.73-7.97 범위였고, 수온은 27.2-31.3 ℃ 범위였다. DO의 경우 4.88-4.46 범위였고, 염분은 13.83-24.30 범위였다. 정점 간 큰 차이를 보인 것은 수온과 염분이었다. 니질 함량 17.5-24.7의 범위로, 해당 정점

이 Sand와 Mud가 혼합된 퇴적환경인 것을 알 수 있었다.

3.2 저서 규조류 군집 개괄

한국과 중국의 모래갯벌에서 발견된 규조류는 33과 58속 210종으로 분류되었다. 이 중에서 종 수준까지 동정된 것은 101종이다. Round et al. (1990)을 참고하여 한국과 중국에서 출현한 규조류의 분류체계를 Table 2로 정리하였다.

Table 2. Classification of diatoms in Korea and China sand flat.

Category	Family	Genus
CENTRALES	Aulacoseirales	*Aulacoseira*
	Paraliaceae	*Paralia*
	Stephanodiscales	*Cyclostephanos*
		Cyclotella
		Discostella
		Stephanodiscus
	Stephanopyxidacea	*Stephanopyxis*
	Thalassisiraceae	*Thalassiosira*
ARAPHIDOINEAE	Cymatosiraceae	*Plagiogrammaopsis*
	Fragilariaceae	*Fragilaria*
		Neofragilaria
		Odontidium
		Staurosirella
	Grammatophoraceae	*Grammatophora*
	Plagiogrammaceae	*Dimeregramma*
		Plagiogramma
	Rhaphoneidaceae	*Neodelphineis*
		Rhaphoneis
	Staurosiraceae	*Opephora*
		Staurosira
	Surirellaceae	*Surirella*
	Ulnariaceae	*Tabularia*
		Trachysphenia
	Achnanthaceae	*Achnanthes*
		Planothidium
	Anomoeoneidaceae	*Staurophora*

Table 2. Continued

Category	Family	Genus
RAPHIDOINEAE	Bacillariaceae	*Nitzschia*
		Tryblionella
	Berkeleyaceae	*Berkeleya*
		Lunella
	Catenulaceae	*Amphora*
		Catenula
	Cocconeidaceae	*Anorthoneis*
		Cocconeis
		Cocconeiopsis
	Cymbellaceae	*Cymbella*
	Diadesmidaceae	*Luticola*
	Diploneidaceae	*Diploneis*
	Entomoneidaceae	*Entomoneis*
	Gomphonemataceae	*Gomphonema*
	Lyrellaceae	*Lyrella*
		Moreneis
		Petroneis
	Naviculaceae	*Caloneis*
		Chamaepinnularia (?)
		Fogedia
		Gyrosigma
		Haslea
		Hippodonta
		Navicula
		Parlibellus
		Seminavis
	Pinnulariaceae	*Pinnularia*
	Plagiotropidaceae	*Plagiotropis*
	Pleurosigmataceae	*Pleurosigma*
		Donkinia

* (?) : 분류학적 위치가 불분명함 (Naviculales incertae sedis)

Table 2. Continued

Category	Family	Genus
RAPHIDOINEAE	Scolioneidaceae	*Scolioneis*
	Scoliotropidaceae	*Diademoides*
		Biremis
	Sellaphoraceae	*Fallacia*

한국과 중국의 모래갯벌 정점에서 출현한 모든 종의 종 리스트를 상대적인 수도(Relative abundance)와 함께 Table 3에 정리하였다.

3.2.1 백합등 모래갯벌

한국의 백합등 모래갯벌 2 정점(BH 1, BH 2)에서 출현한 규조류는 총 33개 속 102종이 관찰되었다(Table 3). 해당 정점에서 우점하는 상위 5개의 속으로는 *Navicula*, *Amphora*, *Fragilaria*, *Planothidium*, *Parilbellus*가 관찰되었다.

가장 많은 종수를 보인 속은 *Navicula*로, 해당 속에서 관찰된 종에는 *Navicula arenaria*, *Navicula cancellata*, *Navicula flanatica*, *Navicula gregaria*, *Navicula* sp. 1, *Navicula* sp. 2, *Navicula* sp. 3, *Navicula* sp. 4, *Navicula* sp. 5, *Navicula* sp. 6, *Navicula* sp. 7, *Navicula* sp. 8, *Navicula* sp. 9, *Navicula* sp. 10, *Navicula* sp. 11, *Navicula* sp. 12, *Navicula* sp. 13, *Navicula* sp. 14, *Navicula* sp. 16, *Navicula* sp. 17을 포함한 20개의 종이 관찰되었다. 백합등 모래 갯벌 정점 2 곳에서 가장 많이 출현한 종은 *Navicula*의 *Navicula arenaria* 종이었다(Table 3). 그 다음으로 많은 종수를 보인 속은 *Amphora*로, 해당 속에서 관찰된 종은 *Amphora arenicola*, *Amphora* cf. *gacialis*, *Amphora* cf. *terroris*, *Amphora costata*, *Amphora holsatica*, *Amphora lurzuluta*, *Amphora richardiana*, *Amphora* sp. 1, *Amphora* sp. 2, *Amphora* sp. 3, *Amphora* sp. 4, *Amphora* sp. 5, *Amphora* sp. 6, *Amphora* sp. 8, *Amphora* sp. 9를 포함한 15개의 종이 관찰되었다. 이 중에 *Amphora holsatica* 종이 해당 정점에서 *Amphora* 속 중 가장 많이 출현한 종으로 관찰되었다. *Fragilaria*는 속에는 3개의 종이 관찰되었고,

Fragilaria sopotensis 종은 *Fragilaria* 속에서 가장 많은 수가 관찰되었다. 이어서 *Planothidium* 속은 6개의 종이 관찰되었고, 이 중에 *Planothidium* sp. 1 종이 가장 많이 관찰되었다. 우점하는 상위 5개의 속 중 마지막으로 많이 관찰된 *Parilbellus*는 해당 정점에서 총 4종이 관찰되었고, 이 중에서 *Parilbellus* sp. 2 종이 가장 많이 출현하였다.

우점하는 상위 5개 속은 우상형(羽狀形) 규조류에 속하며, 이외에 중심형(中心形) 규조류 또한 관찰되었다. 출현한 중심형 규조류 속에는 *Aulacoseira*, *Cyclostephanos*, *Cyclotella*, *Stephanodiscus*, *Thalassiosira* 5개의 속이 관찰되었다. 이 중에서 가장 높은 비율로 출현한 속은 *Aulacoseira* 속으로, *Aulacoseira ambigua*, *Aulacoseira granulata* 2개의 종이 관찰되었다(Table 3). *Aulacoseira* 속은 이전의 낙동강 하구 연구 논문에서도 우점 부유성(Planktonic) 규조류(Cho, 1999)로 언급이 된바 있는 속이다.

BH 1정점에서 가장 우점하는 종은 *Navicula arenaria* 종으로 계수한 300개체 중 46개체가 관찰되었고, 상대적인 수도는 15.3 %를 차지하였다(Table 3). BH 2 정점에서는 *Navicula flanatica* 종이 가장 우점하는 종으로 나타났으며, 계수한 300개체 중 21개체가 관찰되었고, 상대적인 수도는 7.0 %를 차지하였다.

3.2.2 푸투안 하구 모래갯벌

중국의 푸투안 하구 모래갯벌 2정점(RZ 1, RZ 2)에서 출현한 규조류는 47속 144종이 관찰되었다(Table 3). 해당정점에서 우점하는 상위 5개의 속에는 *Navicula*, *Nitzschia*, *Amphora*, *Cocconeis*, *Fallacia*가 관찰되었다.

가장 많은 종수를 보인 속은 *Navicula*로, 이 속은 *Navicula arenaria*, *Navicula bipustulata*, *Navicula* cf. *perrhombus*, *Navicula flanatica*, *Navicula spartinetensis*, *Navicula* sp. 5, *Navicula* sp. 6, *Navicula* sp. 7, *Navicula* sp. 10, *Navicula* sp. 12, *Navicula* sp. 13, *Navicula* sp. 14, *Navicula* sp. 15, *Navicula* sp. 16, *Navicula* sp. 17, *Navicula* sp. 18을 포함한 15개의 종이 관찰되었다. *Navicula* 속에서 *Navicula* sp. 17 종이 가장 많이 출현하는 것으로 관찰되었다 (Table 3). 다음으로 많은 종수를 보인 *Nitzschia* 속에는 *Nitzschia adducta*,

Nitzschia cf. *miserabilis*, *Nitzschia granulata*, *Nitzschia hungarica*, *Nitzschia lorenziana*, *Nitzschia panduriformis*, *Nitzschia* sp. 1, *Nitzschia* sp. 2를 포함한 8개의 종이 관찰되었고, 해당 속에서 가장 많이 출현한 종은 *Nitzschia hungarica*로 관찰되었다. *Amphora*는 속에는 19개의 종이 관찰되었고, *Amphora arenicola* 종은 *Amphora* 속에서 가장 많은 수가 관찰되었다. 이어서 *Cocconeis* 속은 8개의 종이 관찰되었고, 이 중에 *Cocconeis scutellum* 종이 가장 많이 관찰되었다. 우점하는 상위 5개의 속 중 마지막으로 많이 관찰된 *Fallacia*는 해당 정점에서 총 13종이 관찰되었고, 이 중에서 *Fallacia forcipata* 종이 가장 많이 출현하였다(Table 3).

해당 정점에서 우점하는 상위 5개 속 또한 우상형 규조류에 속하며, 이외에 출현한 중심형 규조류의 경우 *Cyclotella, Palaria* 2개의 속이 관찰되었다. 이 중에서 가장 높은 비율로 출현한 속은 *Cyclotella* 속으로 *Cyclotella meneghiniana*, *Cyclotella striata* 2개의 종이 관찰되었다(Table 3).

RZ 1정점에서 가장 우점하는 종으로는 *Navicula* sp. 17 종이 53개체가 관찰되었고, 상대적인 수도는 17.7 %를 차지하였다. *Navicula* sp. 17은 전체 연구지역에서 단일 종으로는 가장 높은 상대적인 수도를 나타냈다(Table 3). RZ 2정점에서는 *Navicula* sp. 10 종이 28개체가 관찰되었고, 상대적인 수도는 9.3 %를 차지하였다.

Table 3. Species list of Korea and China sand flat, along with their relative abundance in each of sampling location.

Diatom taxa	BH 1		BH 2		RZ 1		RZ 2	
	No.	%	No.	%	No.	%	No.	%
Achnanthes cf. *brevipes*	1	0.3		0.0		0.0		0.0
Achnanthes sancti-paulii		0.0		0.0	2	0.7		0.0
Achnanthes sp. 1		0.0	1	0.3		0.0		0.0
Achnanthes sp. 2	5	1.7	2	0.7		0.0		0.0
Achnanthes sp. 3		0.0		0.0		0.0	2	0.7
Amphora arenicola	5	1.7	3	1.0	5	1.7	3	1.0
Amphora cf. *gacialis*	1	0.3		0.0		0.0		0.0
Amphora cf. *terroris*		0.0	1	0.3		0.0		0.0
Amphora costata	4	1.3	4	1.3	1	0.3		0.0
Amphora helenesis		0.0		0.0	1	0.3	3	1.0
Amphora holsatica	28	9.3	20	6.7	3	1.0		0.0
Amphora lurzuluta		0.0	1	0.3		0.0		0.0
Amphora maletractata var. *constricta*		0.0		0.0		0.0	2	0.7
Amphora richardiana	17	5.7	16	5.3	1	0.3		0.0
Amphora sp. 1		0.0	3	1.0		0.0		0.0
Amphora sp. 2		0.0	2	0.7		0.0		0.0
Amphora sp. 3	3	1.0	8	2.7		0.0		0.0
Amphora sp. 4	7	2.3	6	2.0	1	0.3		0.0
Amphora sp. 5	2	0.7		0.0		0.0		0.0
Amphora sp. 6		0.0	11	3.7	1	0.3	3	1.0
Amphora sp. 7		0.0		0.0		0.0	1	0.3
Amphora sp. 8		0.0	1	0.3		0.0		0.0
Amphora sp. 9		0.0	1	0.3	2	0.7	4	1.3
Amphora sp. 10		0.0		0.0	2	0.7	6	2.0
Amphora sp. 11		0.0		0.0		0.0	1	0.3
Amphora sp. 12		0.0		0.0	2	0.7	2	0.7
Amphora sp. 13		0.0		0.0		0.0	1	0.3
Amphora sp. 14		0.0		0.0	1	0.3		0.0
Amphora sp. 15		0.0		0.0	1	0.3	1	0.3
Amphora sp. 16		0.0		0.0	1	0.0		0.0
Amphora sp. 17		0.0		0.0		0.0	1	0.3
Amphora sp. 18		0.0		0.0		0.0	1	0.3
Anorthoneis sp. 1		0.0		0.0	1	0.3	3	1.0
Anorthoneis sp. 2		0.0		0.0		0.0	1	0.3
Aulacoseira ambigua	1	0.3		0.0		0.0		0.0
Aulacoseira granulata	5	1.7	5	1.7		0.0		0.0
Berkeleya cf. *rutilans*		0.0		0.0		0.0	1	0.3
Biremis aff. *ambigua*		0.0		0.0	5	1.7	14	4.7
Biremis sp.		0.0		0.0	2	0.7		0.0
Caloneis crassa	2	0.7	2	0.7		0.0		0.0
Caloneis westii	1	0.3	4	1.3		0.0		0.0
Catenula sp.		0.0		0.0	1	0.3		0.0
Chamaepinnularia sp.		0.0		0.0	4	1.3	1	0.3

Table 3. Continued

Diatom taxa	BH 1		BH 2		RZ 1		RZ 2	
	No.	%	No.	%	No.	%	No.	%
Cocconeiopsis cf. *patrickae*		0.0		0.0	1	0.3		0.0
Cocconeiopsis sp.		0.0		0.0	1	0.3	1	0.3
Cocconeis cf. *distans*		0.0		0.0	1	0.3		0.0
Cocconeis cf. *irregularis*		0.0		0.0		0.0	2	0.7
Cocconeis cf. *sigillata*		0.0		0.0	2	0.7	1	0.3
Cocconeis placentula	4	1.3		0.0		0.0	1	0.3
Cocconeis scutellum		0.0		0.0		0.0	4	1.3
Cocconeis sp. 1		0.0		0.0		0.0	1	0.3
Cocconeis sp. 2		0.0		0.0	1	0.3		0.0
Cocconeis sp. 3		0.0		0.0		0.0	1	0.3
Coscinodiscus striatus		0.0		0.0	2	0.7		0.0
Cyclotella meneghiniana	2	0.7	2	0.7		0.0	1	0.3
Cyclotella striata		0.0		0.0	5	1.7		0.0
Cycolstephanos dubius	2	0.7		0		0		0
Cycolstephanos sp.	6	2.0	2	0.7		0.0		0.0
Cymbella affiniformis	1	0.3	1	0.3		0.0		0.0
Diademoides luxuriosa		0.0	3	1.0		0.0		0.0
Dimeregramma minor		0.0		0.0		0.0	1	0.3
Dimeregraama sp. nov.		0.0		0.0		0.0		0.0
Diploneis aestuarii		0.0		0.0	2	0.7	1	0.3
Diploneis cf. *litoralis*		0.0		0.0	3	1.0		0.0
Diploneis cf. *stroemii*		0.0		0.0	1	0.3		0.0
Diploneis nitescens	1	0.3		0.0	24	8.0	2	0.7
Diploneis sp. 1		0.0		0.0		0.0	1	0.3
Diploneis sp. 2		0.0		0.0		0.0	1	0.3
Discotella stelligera	4	1.3		0.0		0.0		0.0
Discotella sp.	1	0.3		0.0		0.0		0.0
Donkinia recta		0.0		0.0		0.0	1	0.3
Entomoneis alata		0.0		0.0		0.0	2	0.7
Entomoneis sp.		0.0		0.0	1	0.3		0.0
Fallacia forcipata		0.0		0.0		0.0	10	3.3
Fallacia litoricola	2	0.7		0.0		0.0		0.0
Fallacia scaldensis	1	0.3	1	0.3	1	0.3		0.0
Fallacia subforciputa		0.0		0.0	1	0.3	5	1.7
Fallacia tenera	1	0.3		0.0	1	0.3	2	0.7
Fallacia sp. 1		0.0	3	1.0		0.0	1	0.3
Fallacia sp. 2		0.0		0.0	2	0.7	1	0.3
Fallacia sp. 3		0.0		0.0	1	0.3	1	0.3
Fallacia sp. 4		0.0		0.0		0.0	1	0.3
Fallacia sp. 5		0.0		0.0		0.0	5	1.7
Fallacia sp. 6		0.0		0.0		0.0	3	1.0
Fallacia sp. 7		0.0		0.0		0.0	1	0.3
Fallacia sp. 8		0.0		0.0		0.0	1	0.3
Fallacia sp. 9		0.0		0.0		0.0	2	0.7
Fogedia densa		0.0		0.0		0.0	2	0.7

Table 3. Continued

Diatom taxa	BH 1		BH 2		RZ 1		RZ 2	
	No.	%	No.	%	No.	%	No.	%
Fogedia elliptica	1	0.3	1	0.3		0.0		0.0
Fogedia lyra		0.0		0.0	1	0.3	3	1.0
Fragilaria gedanensis	1	0.3	2	0.7		0.0		0.0
Fragilaria sopotensis	11	3.7	19	6.3		0.0		0.0
Fragilaria vaucheriae	7	2.3	1	0.3		0.0		0.0
Fragilaria sp.		0.0		0.0		0.0	2	0.7
Geissleria decussis	2	0.7		0.0		0.0		0.0
Gomphonema micropus	2	0.7		0.0		0.0		0.0
Gomphonema sp. 1		0.0		0.0	1	0.3		0.0
Gomphonema sp. 2	2	0.7	1	0.3		0.0		0.0
Grammatophora cf. *marina*		0.0		0.0		0.0	1	0.3
Gyrosigma sterrenburgii	1	0.3		0.0		0.0		0.0
Gyrosigma sp. 1		0.0	1	0.3	5	1.7	5	1.7
Gyrosigma sp. 2		0.0		0.0	1	0.3		0.0
Hasler sp.		0.0		0.0	1	0.3		0.0
Hippodonta linearis	10	3.3	8	2.7	9	3.0	1	0.3
Hippodonta sp.		0.0		0.0	1	0.3		0.0
Lunella sp.	1	0.3		0.0		0.0		0.0
Lyrella hennedyi		0.0		0.0		0.0		0.0
Lyrella cf. *spectabilis*		0.0		0.0		0.0		0.0
Moreneis hexagona	1	0.3	1	0.3		0.0		0.0
Navicula arenaria	46	15.3	17	5.7		0.0	9	3.0
Navicula bipustulata		0.0		0.0	2	0.7	5	1.7
Navicula cancellata	1	0.3	1	0.3		0.0		0.0
Navicula cf. *perrhombus*		0.0		0.0	1	0.3		0.0
Navicula flanatica	4	1.3	21	7.0	1	0.3		0.0
Navicula gregaria	2	0.7	2	0.7		0.0		0.0
Navicula spartinetensis		0.0		0.0		0.0	8	2.7
Navicula sp. 1	1	0.3		0.0		0.0		0.0
Navicula sp. 2	4	1.3	2	0.7		0.0		0.0
Navicula sp. 3	21	7.0	3	1.0		0.0		0.0
Navicula sp. 4	1	0.3		0.0		0.0		0.0
Navicula sp. 5	2	0.7	1	0.3		0.0	1	0.3
Navicula sp. 6	3	1.0	6	2.0	3	1.0		0.0
Navicula sp. 7	1	0.3		0.0	1	0.3	13	4.3
Navicula sp. 8	2	0.7		0.0		0.0		0.0
Navicula sp. 9		0.0	2	0.7		0.0		0.0
Navicula sp. 10	1	0.3		0.0	9	3.0	28	9.3
Navicula sp. 11	1	0.3		0.0		0.0		0.0
Navicula sp. 12		0.0	1	0.3	5	1.7	20	6.7
Navicula sp. 13	4	1.3	6	2.0	10	3.3	15	5.0
Navicula sp. 14	1	0.3	2	0.7		0.0	3	1.0
Navicula sp. 15	1	0.3		0.0	1	0.3	1	0.3
Navicula sp. 16		0.0	1	0.3	1	0.3	1	0.3
Navicula sp. 17		0.0		0.0	53	17.7	1	0.3

Table 3. Continued

Diatom taxa	BH 1		BH 2		RZ 1		RZ 2	
	No.	%	No.	%	No.	%	No.	%
Navicula sp. 18		0.0		0.0		0.0	1	0.3
Neodelphineis pelagica		0.0		0.0	1	0.3	1	0.3
Neodelphineis sp		0.0		0.0		0.0	5	1.7
Neofragilaria cf. *nicobarica*	2	0.7		0.0		0.0		0.0
Nitzschia adducta		0.0		0.0	6	2.0		0.0
Nitzschia alpina	3	1.0		0.0		0.0		0.0
Nitzschia amphibia	2	0.7	15	5.0		0.0		0.0
Nitzschia cf. *miserabilis*		0.0		0.0	1	0.3	1	0.3
Nitzschia desertorum	2	0.7		0.0		0.0		0.0
Nitzschia granulata		0.0		0.0	2	0.7		0.0
Nitzschia hungarica		0.0		0.0	26	8.7	6	2.0
Nitzschia lorenziana		0.0		0.0	1	0.3	1	0.3
Nitzschia panduriformis		0.0		0.0	1	0.3	3	1.0
Nitzschia solita		0.0	4	1.3		0.0		0.0
Nitzschia sp. 1		0.0		0.0	17	5.7	3	1.0
Nitzschia sp. 2		0.0		0.0		0.0	1	0.3
Odontidium cf. *harrisonii*	1	0.3		0.0		0.0	1	0.3
Odontidium cf. *tabellaria*	1	0.3		0.0		0.0	2	0.7
Opephora cf. *martyi*		0.0		0.0		0.0		0.0
Opephora cf. *mutabilis*		0.0	1	0.3	8	2.7	2	0.7
Opephora pacifica	2	0.7	1	0.3		0.0	1	0.3
Opephora sp.		0.0		0.0	1	0.3		0.0
Palaria sulcata		0.0		0.0	2	0.7		0.0
Parilbellus cf. *plicatus*		0.0		0.0	2	0.7		0.0
Parilbellus protracta		0.0	1	0.3		0.0		0.0
Parilbellus sp. 1	3	1.0	10	3.3	1	0.3		0.0
Parilbellus sp. 2	6	2.0	10	3.3	8	2.7		0.0
Parilbellus sp. 3	1	0.3		0.0	2	0.7		0.0
Parilbellus sp. 4		0.0		0.0	1	0.3	1	0.3
Parilbellus sp. 5		0.0		0.0		0.0	8	2.7
Petroneis sp.		0.0		0.0	1	0.3		0.0
Pinnularia trevelyana		0.0	4	1.3		0.0		0.0
Pinnularia sp. 1	1	0.3		0.0		0.0		0.0
Pinnularia sp. 2		0.0		0.0		0.0	1	0.3
Pinnularia sp. 3		0.0	1	0.3		0.0		0.0
Pinnularia sp. 4		0.0		0.0	1	0.3		0.0
Pinnularia sp. 5		0.0		0.0		0.0	1	0.3
Plagiogramma sp.		0.0		0.0	7	2.3		0.0
Plagiogrammopsis cf. *minima*		0.0		0.0		0.0	1	0.3
Plagiotropis cf. *tayecta*	1	0.3	1	0.3		0.0		0.0
Planothidium delicatulum	5	1.7	2	0.7	1	0.3	9	3.0
Planothidium cf. *lilljeborgei*		0.0		0.0		0.0	2	0.7
Planothidium engelbrechtii	4	1.3		0.0		0.0	3	1.0
Planothidium graum	2	0.7		0.0		0.0		0.0
Planothidium pericavum	4	1.3	4	1.3		0.0		0.0
Planothidium sp. 1	9	3.0	2	0.7	1	0.3		0.0

Table 3. Continued

Diatom taxa	BH 1		BH 2		RZ 1		RZ 2	
	No.	%	No.	%	No.	%	No.	%
Planothidium sp. 2	1	0.3		0.0	1	0.3		0.0
Planothidium sp. 3		0.0		0.0	1	0.3		0.0
Pleurosigma sp. 1		0.0		0.0		0.0	2	0.7
Pleurosigma sp. 2		0.0		0.0	1	0.3		0.0
Pleurosigma sp. 3		0.0		0.0		0.0	1	0.3
Rhaphoneis amphiceros		0.0		0.0		0.0	2	0.7
Rhaphoneis sp.		0.0		0.0		0.0	1	0.3
Scolioneis sp. 1		0.0		0.0	1	0.3		0.0
Scolioneis sp. 2		0.0		0.0		0.0	1	0.3
Seminavis sp. 1		0.0		0.0	1	0.3		0.0
Seminavis sp. 2		0.0		0.0		0.0	1	0.3
Staurophora salina		0.0	1	0.3	1	0.3	6	2.0
Staurophora sp. 1		0.0	2	0.7	1	0.3		0.0
Staurophora sp. 2		0.0	2	0.7	1	0.3		0.0
Staurophora sp. 3		0.0	5	1.7		0.0		0.0
Staurosira construens var. *binodis*	2	0.7	11	3.7		0.0		0.0
Staurosirella cf. *pinnata*	1	0.3		0.0		0.0	1	0.3
Staurosirella sp. 1	1	0.3	2	0.7		0.0		0.0
Staurosirella sp. 2		0.0		0.0		0.0	1	0.3
Stephanodiscus hantzschii		0.0	1	0.3		0.0		0.0
Stephanodiscus sp.	1	0.3		0.0		0.0		0.0
Stephanopyxis sp.		0.0		0.0	2	0.7	1	0.3
Tabularia cf. *fasciculata*		0.0		0.0		0.0	2	0.7
Thalassiosira oestrupii var. *venrickiae*		0.0		0.0	3	1.0		0.0
Thalassiosira hyperborean var. *lacunsa*	1	0.3	1	0.3		0.0		0.0
Trachysphenia cf. *acuminata*		0.0		0.0		0.0	1	0.3
Trachysphenia cf. *australis*		0.0		0.0	1	0.3	4	1.3
Tryblionella apiculata		0.0	15	5.0		0.0		0.0
Tryblionella hungarica		0.0	1	0.3		0.0		0.0
UI 1		0.0		0.0	2	0.7		0.0
Number of observed species	300		300		300		300	

* UI 종은 형태만으로 속을 알 수 없는 종에 대해서 UI로 표현하였다.

3.3 출현종의 기재

종의 기재는 영문으로 작성하였고, 기재 방식은 다음의 내용에 따라 작성하였다.

새로운 속을 기재할 때는 이어서 작성하지 않고 새로운 페이지에 기재하였다. 또한 그 속명을 작성하고, 그 속을 대표하는 대표종의 학명을 작성하였다. 대표종의 학명이 최근에 변경된 경우, 변경된 대표종의 학명도 함께 기재하였다. 그 다음 출현한 종을 알파벳순으로 정리하여 작성하였다. 출현종의 기재는 출현종의 학명과 출현종이 최초로 기재된 문헌(Literature; Lit.)을 작성하였고, 기본명(Basionym; Bas.)이 있으면 작성하였으나, 없는 경우 학명의 동의어(Synonym; syn.)를 작성하였다. Syn.도 없는 경우에는 Syn.도 생략하고 관찰 내용과 분포에 대해서 작성하였다. 속의 기재 순서는 분류체계 Table 2에 나열한 순서대로 작성하였다.

본 논문에서 기재에 필요한 용어는 박 (2005)에서 정리된 내용을 참고하였다. 기재와 관련된 용어의 설명은 다음과 같다. 용어에 대한 그림 설명은 Fig 2와 같이 나타내었다.

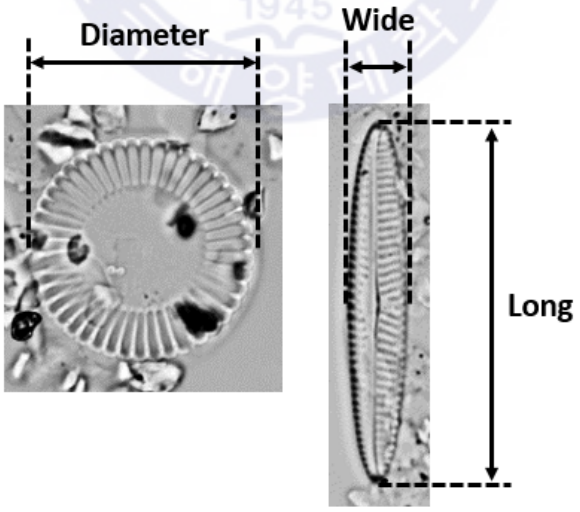

Fig. 2 Morphological features on species substrates.

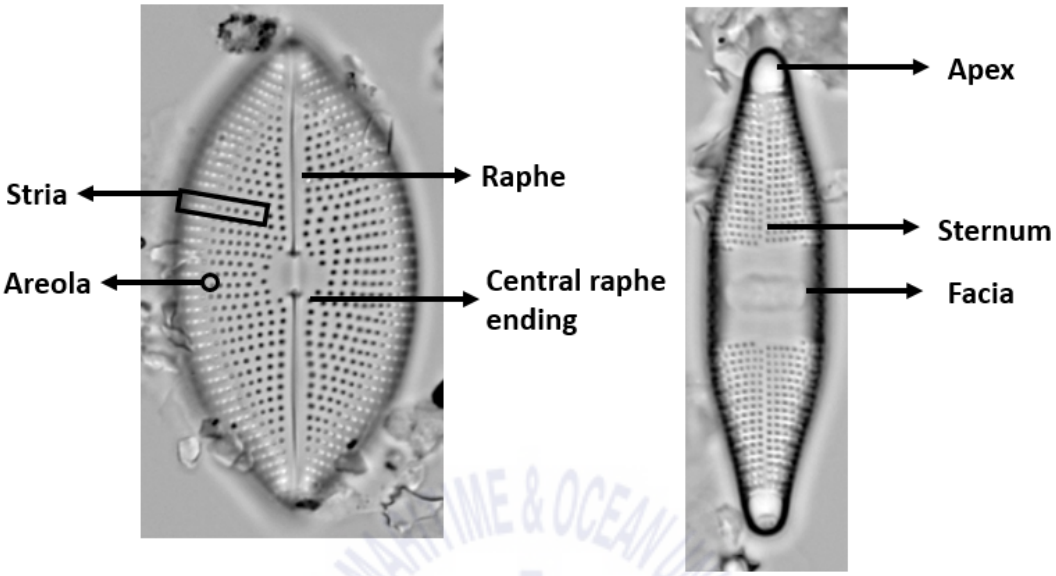

Fig. 2 Morphological features on species substrates.

- 용어 설명

1) Diameter : 중심형 규조류에서 세포의 직경을 의미함.
2) Wide : 우상형 규조류에서 세포의 너비를 의미함.
3) Long : 우상형 규조류에서 세포의 높이를 의미함.
4) Stria : Areola 혹은 Pore가 열 지어 있는 구조를 의미함.
5) Areola : 세포의 규산질 기층에 나타나는 구멍으로, 세포의 안과 밖이 서로 통하나 일반적으로 체막에 막혀 있는 구조를 의미함. 종에 따라 형태가 다양함.
6) Raphe : 우상형 규조류에서 나타나는 구조로, 세포의 중심에서 세포벽이 갈라진 틈 형태로 나타나며, 종에 따라 나타나는 위치가 다를 수 있고, 종에 따라 상각과 하각에 모두 나타나거나 한 쪽에만 나타기도 함.
7) Central raphe ending : 세포의 중앙영역에서 Raphe가 끝나는 지점을 의미하며, 종에 따라 형태가 다양함.
8) Apex : 중상형 규조류에서 세포의 끝을 의미, 종에 따라 Pore fields 또는 Terminal raphe ending이 나타남.
9) Sternum : Areola나 Pore가 없어서, 광학현미경상으로 투명하게 보이는 구조로, 종에

따라 너비가 상이하고, 형태도 다양함.

10) Facia : 우상형 규조류 중, 세포의 중앙영역에서 가로방향으로 나타나는 투명하게 보이는 구조로, Areola나 Pore, Stria가 나타나지 않는 구조를 의미함.

CENTRALES

Aulacoseira Thwaites, 1848

Holotype Species : *Melosira crenulata* (Ehrenberg) Kützing

Currently accepted name for the type species : *Aulacoseira crenulata* (Ehrenberg) Thwaites

Aulacoseira ambigua (Grunow) Simonsen

Bas. : *Melosira crenulata* var. *ambigua* Grunow

Lit. : Kramer & Lange-Bertalot 1991, p. 25, figs 1:5, 2:3, 21:1-16; Cohu 1991, p. 409-421, figs. 1-51; Kobayasi and Nozawa 1981, p. 125-127, figs. 1-23

Observation : Cell shape is long cylinder in girdle view. Occasionally, cells may be curved as well as straight in the girdle view. Frustules have the two valve types of linking valve and separation. Valve diameter is 2.5 ㎛. Areolae on valve mantle 15 in 10 ㎛.

Distribution : *A. ambigua* is found in eutrophic waters (Houk 2003). In Korea, Cho (1999) has described this species in the Naktong River. Shin (2003) has described Pyeongtaek reservoir.

Aulacoseira granulata (Ehrenberg) Simonsen

Bas. : *Melosira granulata* (Ehrenberg) Ralfs 1861

Lit : Kramer & Lange-Bertalot 1991, pl. 22, pl. 17, figs 1-10, figs 1-14, pl. 19, figs 1-9

Observation : Cell shape is long cylinder in girdle view. Frustules has the two valve types of linking valve and separation. Valves diameter is 6.7-12 ㎛. Areolae on valve mantle 6-9 in 10 ㎛. Ratio range of dimeter (D) / mantle height (H) are 4-8.5.

Distribution : In Korea, *A. granulata* reported from Han river (Lee and Yoon 1994), Naktong River Estuary (Cho 1999), Songdo tidal flat (Noh et al. 2001).

Paralia Heiberg, 1863

Holotype Species : *Paralia marina* (W.Smith) Heiberg

Paralia sulcata (Ehrenberg) Cleve

Lit. : Cleve, P.T. (1873). 1(11): 1-13, 3 pls.

Observation : Valve is discoid shaped. Valves diameter are 14-16.6 ㎛. Valve type are two shapes. The shape of the linking and separation valves is different and can be distinguished on the microscope.

Distribution : In korea, Cho (1988) described *P. sulcata* from the Kyonggi Bay. Also Oh and Koh(1995) reported *P. sulcata* from the Mangyung-dongjin.

Cyclostephanos Round, 1987

Holotype Species : *Cyclostephanos novae-zeelandiae* (Cleve) Round

Cyclostephanos dubius

Lit. : Theriot, E., Håkansson, H., Kociolek, J.P., Round, F.E. & Stoermer, E.F. (1988 '1987'), British Phycological Journal 22(4) : 345-347.

Observation : Valve is discoid shaped. Valves diameter are 12-13.3 ㎛. The line of areolae in the valve is radial. The central area is concave. So, under the microscope, the central and marginal areas appear to be separated. Marginal striated, 12 in 10 ㎛.

Distribution : Ha et al. (1998) reported a from the Naktong River. Also Kim et al. (2008) reported from korea stream.

Cyclostephanos sp.

Observation : Valve is discoid shaped. Valves diameter are 6.7 ㎛. The line of areolae in the marginal valve is radial. Marginal striated, 15 in 10 ㎛

Cyclotella (Kutzing) Brebisson, 1838

Holotype Species : *Cyclotella tecta* Håkansson & R.Ross

Currently accepted name for the type species: *Cyclotella distinguenda* Hustedt

Cyclotella meneghiniana Kützing

Lit. : Kützing 1844, Die Kieselschaligen Bacillarien oder Diatomeen. pp. [i-vii], [1]-152, pls 1-30. Nordhausen: zu finden bei W. Köhne.

Observation : Valve is discoid shaped. Valves diameter are 10-22 ㎛. Valve is divided central area and marginal striated area. Central area is tangentially wealky undulated. Central areas has 2 fultoportulae with 0-3 satellite pore. Marginal striated, 9 in 10 ㎛.

Distribution : *Cyclotella meneghiniana* have been found in varied habitats including brackish water, and both eutrophic and oligotrophic freshwater (Håkansson 2002, Tanaka 2007). In Korea, Lee and Lee (1988) firstly recorded *C. meneghiniana* in the Han River and Ulsan Bay near Taehwa River estuary. Cho (1996) described *C. meneghiniana* from the Naktong River. Recently, Park et al. (2013) investigated and described *C. meneghiniana* from the Korean coast (East Sea, South Sea, Yellow Sea).

Cyclotella striata (Kützing) Grunow

Bas. : *Coscinodiscus striatus* Kützing

Lit. : Cleve, P. T. & Grunow, A. (1880), Kongliga Svenska Vetenskaps - Akademiens Handlingar 17(2): 1-121, 7 pls.

Observation : Valve is discoid shaped. Valves diameter are 15.5-20.5 ㎛. Marginal striae 9-15 in 10 ㎛. Central area rugged, tangentially undulated with clear distinction between concave and convex.

Discotella V.Houk & R.Klee, 2004

Holotype Species : *Discostella stelligera* (Cleve & Grunow) Houk & Klee

Discostella stelligera (Cleve & Grunow) Houk & Klee

Lit. : Houk, V. & Klee, R. (2004). The stelligeroid taxa of the genus Cyclotella (Kützing) Brébisson (Bacillariophyceae) and their transfer into the new genus Discostella gen. nov. Diatom Research 19(2): 203-228.

Bas. : *Cyclotella meneghiniana* var. *stelligera* Cleve & Grunow

Observation : Valve is discoid shaped. Valve face concave or convex in the center area. Valves diameter 8.7-16.7 ㎛. A big pore appears in the center and central striae form a stellate pattern. The length of the central striae is irregular, but the length of the marginal striae is almost regular. Marginal striated, 15-18 in 10 ㎛. Hyaline is formed as wide as a band between the central area and the marginal area.

Discostella sp.

Observation : Valve is discoid shaped. Valve face concave or convex in the center area. Valves diameter 20-22.7 ㎛. Central striae 12 in 10 ㎛. and, marginal striae 18 in 10 ㎛. Hyaline is formed as wide as a band between the central area and the marginal area.

Stephanodiscus Ehrenberg, 1845

Holotype Species : *Stephanodiscus niagarae* Ehrenberg

Stephanodiscus hantzschii Grunow

Lit. : Cleve, P. T. & Grunow, A. (1880). Kongliga Svenska Vetenskaps - Akademiens Handlingar 17(2): 1-121, 7 pls.

Observation : Valve is discoid shaped. Valves diameter are 10 ㎛. Marginal striae 9-15 in 10 ㎛. The line of areolae in the valve is radial. Spines occur in a single row around the edge of the valve face.

Distribution : In Korea, Jeong et al. (2006) recorded *S. hantzschii* in the Naktong River and Jung et al. (2009) reported in the Han River.

Stephanodiscus sp.

Observation : Valve is discoid shaped. Valves diameter are 10 ㎛. Marginal striae 9-15 in 10 ㎛. The line of areolae in the valve is radial.

Stephanopyxis (Ehrenberg) Ehrenberg, 1845

Holotype Species : *Pyxidicula aculeata* Ehrenberg

Currently accepted name for the type species: *Stephanopyxis aculeata* (Ehrenberg) Ehrenberg

Stephanopyxis sp.

Observation : Valve is discoid shaped. Valve face is convex in the central area. Valves diameter are 16-24 ㎛. Areolae is 6.6-8.3 at 10 cm in the central area.

Thalassiosira Cleve, 1873

Holotype Species : *Thalassiosira nordenskioeldii* Cleve

Thalassiosira hyperborea var. *lacunosa* G.R.Hasle

Lit. : Hasle & Lange 1989, Phycologia 28(1): 120-135. 129, figs 27, 38, 39

Observation : Valve is discoid shaped. Valves diameter are 15.3-20 ㎛. The central part of the frustule is convex or concave. Areolae somewhat irregular in size and shape.

Thalassiosira oestrupii var. *venrickiae* G.A.Fryxell & G.R.Hasle

Lit. : G.A.Fryxell & G.R.Hasle 1980, American Journal of Botany 67(5): 804-814. 810, 813, figs 11-19 (as ‘venrickae’)

Observation : Valve is discoid shaped. Valves diameter are 14-16 ㎛. Valve face is flat. The areolae are in a eccentric pattern and 19-21 in 10 ㎛. One or two Fultoportulas are located in the central area of the valve. Marginal area has processes 11-13. Marginal strutted processes 3.3-4.7 ㎛ apart.

ARAPHIDOINEAE

Plagiogrammopsis Hasle, Stosch & Syvertsen, 1983

Holotype Species : *Plagiogrammopsis vanheurckii* (Grunow) Hasle, Stosch & Syvertsen

Plagiogrammopsis minima Sabbe & Witkowski comb. nov.

Lit. : Salah 1955, Hydrobiologia 7, p. 91, Pl. I, Fig. 15.

Bas. : *Plagiogramma minimum* Salah

Observation : The valves are lanceolate with rounded. Valve 8.7 ㎛ long and 2.7 ㎛ wide. Due to the pseudoseptum in the central area, the central part of the LM is distinctly constricted. Areolae pattern is rather irregular.

Distribution : *P. minima* has been reported from sandy sediments in the North Sea area and the Portuguese Atlantic coast (Salah 1955, Colijn & Nienhuis 1978, as *Plagiogramma* sp. 1, Vos 1986, Denys 1991, this study) and from North America (Cooper 1995, Witkowski *et al.* 2000).

Fragilaria Lyngbye, 1819

Holotype Species : *Fragilaria pectinalis* (O.F.Müller) Lyngbye

Fragilaria gedanensis Witkowski

Lit. : Witkowski, A. (1993). *Fragilaria gedanensis* sp. nov. (Bacillariophyceae), a new epipsammic diatom species from the Baltic Sea. Nova Hedwigia 56(3/4): 497-503, 2 pls [18 figs].

Observation : Valve is heteropolares. Valve is 8-8.7 ㎛ long and 2.3-2.7 ㎛ wide. Striae is distinctae and parallelae.

Fragilaria sopotensis Witkowski & Lange-Bertalot

Lit. : Petersen, J.B. (1938). *Fragilaria* intermedia-Synedra Vaucheriae. Botaniska Notiser 1938(1-3): 164-170, fig.1.

Bas. : *Exilaria vaucheriae* Kützing

Observation : Valve is heteropolares. Valve is 4.7-8 ㎛ long and 3.3-4.7 ㎛ wide. The striae is Parallel. A sternum crosses the center of the valve.

Fragilaria vaucheriae (Kützing) J.B.Petersen

Lit. : Petersen, J.B. (1938). *Fragilaria* intermedia-Synedra Vaucheriae. Botaniska Notiser 1938(1-3): 164-170, fig.1.

Bas. : *Exilaria vaucheriae* Kützing

Observation : Valve is linear-lanceolatae and capitate. Valve is 28.7-38.7 ㎛ long and 3.3-6 ㎛ wide. Areolae is arranged in transapical uniseriate rows passing over onto the valve. Sternum is expanded on one side at the centre. The striae is Parallel.

Neofragilaria D.M.Williams & Round, 1988, nom. illeg.

(Plagiogrammaceae)

Holotype Species : *Neofragilaria nicobarica* Desikachary, Prasad & Prema

Neofragilaria cf. *nicobarica* Desikachary, Prasad & Prema

Lit. : Desikachary, T.V. & Prema, P. (1987). Diatoms from the Bay of Bengal. In: Atlas of Diatoms. Fasc. III. (Desikachary, T.V. Eds), pp. 1-10, pls. 222-331. Madras: Madras Science Foundation.

Observation : Valve is elliptical. Valve is 28 ㎛ long and 6 ㎛ wide. The spines are lined up along the edge of the valve. Areolae are zigzag. In LM, the areolae is noticeably like a big hole.

Odontidium Kützing, 1844

Holotype Species : *Odontidium hyemale* (Roth) Kützing

Odontidium cf. *harrisonii* Roper

Lit. : Roper, F.C.S. (1854). Some observations on the Diatomaceae of the Thames. Transactions of the Microscopical Society, New Series, London 2: 67-80, pl.VI.

Observation : Cruciate valves have slightly curved ends as they progress to the tips of the valves. Valve is 13.3 ㎛ long and 8.7 ㎛ wide. Areolae is radiate and curved striae formed by long prominent lineolae. The lineolated become shorter as they approach the ends of the striae on the valve face and on the mantle.

Odontidium cf. *tabellaria* W. Smith

Lit. : Smith, W. (1856). A synopsis of the British Diatomaceae; with remarks on their structure, functions and distribution; and instructions for collecting and preserving specimens. Vol. 2 pp. [i-vi] - xxix, 1-107, pls 32-60, 61-62, A-E. London: John van Voorst.

Observation : The valve is rugged and irregular. Valve is 13.3 ㎛ long and 4.7 ㎛ wide. Areolae is radiate and curved striae formed by long prominent lineolae. Sternum is narrow and expanded in the central area.

Staurosirella D.M.Wiliams & Round, 1988

Holotype Species : *Fragilaria lapponica* Grunow

Staurosirella pinnata (Ehrenberg) D.M.Williams & Round

Bas. : *Fragilaria pinnata* Ehrenberg

Lit. : Williams, D.M. & Round, F.E. (1988 '1987'). Revision of the genus *Fragilaria*. Diatom Research 2: 267-288, 58 figs.

Observation : Valve shape is elongate and linear with Sternum. Valve is 16 ㎛ long and 5 ㎛ wide. Areolae is inconspicuous. In LM, Striae seems to be connected in one line. The density of Striae is 9 in 10 ㎛. Striae is

Staurosirella sp

Observation : Valve shape is wide oval with narrow toward apical. Valve is 10.7 ㎛ long and 4.7 ㎛ wide. Areolae is inconspicuous. In LM, Striae seems to be connected in one line. The density of Striae is 15 in 10 ㎛. The formation of Striae in the central area is irregular.

Grammatophora Ehrenberg, 1840

Holotype Species : *Grammatophora angulosa* Ehrenberg

Grammatophora marina (Lyngbye) Kützing

Lit. : Kützing, F.T. (1844). Die Kieselschaligen Bacillarien oder Diatomeen. pp. [i-vii], [1]-152, pls 1-30. Nordhausen: zu finden bei W. Köhne.

Observation : The Valve shape is linear with slightly wider in the center area, and rounded apices. Valve is 25.3 ㎛ long and 6 ㎛ wide. The density of Striae is 18 in 10 ㎛ and parallel. No central area and no Sternum. Large hyaline areas with no areolae in the apices. In the central area, the septum appears dark in the LM where the valve widens.

Distribution : *G. marina* has been reported from sandy sediments in the North Sea area and the Portuguese Atlantic coast (Salah 1955, Colijn & Nienhuis 1978, as *Plagiogramma* sp. 1, Vos 1986, Denys 1991, this study) and from North America (Cooper 1995, Witkowski *et al.* 2000).

Dimeregramma Ralfs, 1861

Holotype Species : *Dimeregramma minus* (W.Gregory) Ralfs

Dimeregramma minus (W.Gregory) Ralfs

Bas. : *Denticula minor* W.Gregory

Lit. : Pritchard, A. (1861). A history of infusoria, including the Desmidiaceae and Diatomaceae, British and foreign. Fourth edition enlarged and revised by J. T. Arlidge, M.B., B.A. Lond.; W. Archer, Esq.; J. Ralfs, M.R.C.S.L. ; W. C. Williamson, Esq., F.R.S., and the author. pp. i-xii, 1- 968, 40 pls. London: Whittaker and Co., Ave Maria Lane.

Observation : Valve shape is elongated with rostrate apices. Valve is 18 ㎛ long and 6.7 ㎛ wide. The density of Striae is 18 in 10 ㎛. Small hyaline areas with no areolae in the apices. SEM observation revealed pore fields in the hyaline of apices. Sternum is narrow and expanded in the central area. Areolae are small and round.

Plagiogramma Greville, 1859

Holotype Species : *Plagiogramma gregoryanum* Greville

Currently accepted name for the type species: *Plagiogramma staurophorum* (W.Gregory) Heiberg

Plagiogramma sp.

Observation : Valve shape is elongated with rostrate apices. Valve is 33.3-39.3 ㎛ long and 8.7-9.3 ㎛ wide. The density of Striae is 18 in 10 ㎛. Small hyaline areas with no areolae in the apices. SEM observation revealed pore fields in the hyaline of apices. Sternum is narrow. Areolae are small and round. Fascia appears transverse in the Central area.

NeoDelphineis Takano, 1982, nom. inval.

Holotype Species : *Neodelphineis pelagica* H.Takano

Neodelphineis pelagica

Lit. : Takano, H. (1982). New and rare diatoms from Japanese marine waters - VIII. *Neodelphineis pelagica* gen. et sp. nov. Bulletin Tokai Regional Fisheries Research Laboratory 106: 45-53.

Observation : The valve shape is elongate. Valve is 14.7 ㎛ long and 3.3 ㎛ wide. The density of Striae is 15 in 10 ㎛ and parallel. No central area. The valve shape is linear, asymmetrical left and right. Sternum is narrow. Striae are transverse, and discontinuous across the Sternum.

Neodelphineis sp.

Observation : The valve shape is elongate with undulate margins. Valve is 10-11.3 ㎛ long and 4-4.7 ㎛ wide. The density of Striae is 18 in 10 ㎛ and parallel. No central area. The valve shape is linear, asymmetrical left and right. Sternum is narrow. Striae are transverse, and discontinuous across the Sternum.

Rhaphoneis Ehrenberg, 1844

Holotype Species : *Rhaphoneis amphiceros* (Ehrenberg) Ehrenberg

Rhaphoneis amphiceros (Ehrenberg) Ehrenberg

Lit. : Ehrenberg, C.G. (1844). Mittheilung über 2 neue Lager von Gebirgsmassen aus Infusorien als Meeres-Absatz in Nord-Amerika und eine Vergleichung derselben mit den organischen Kreide-Gebilden in Europa und Afrik. Bericht über die zur Bekanntmachung Geeigneten Verhandlungen der Königl. Preuss. Akademie Der Wissenschaften zu Berlin 1844: 57-97.

Bas. : *Cocconeis amphiceros* Ehrenberg

Observation : The valve shape is subcircular. Valve is 22.7 ㎛ long and 12 ㎛ wide. The density of Striae is 15 in 10 ㎛ and parallel. The density of Areolae is 12 in 10 ㎛. No central area, wide sternum on vertical axis and the sternum becomes narrower toward the apical.

Rhaphoneis sp.

Observation : The valve shape is subcircular. Valve is 12.7 ㎛ long and 8 ㎛ wide. The density of Striae is 12 in 10 ㎛ and parallel. The density of Areolae is 12 in 10 ㎛. No central area, wide sternum on vertical axis and the sternum becomes narrower toward the apical.

Opephora P.Petit, 1889

Holotype Species : *Opephora pacifica* (Grunow) Petit

Opephora pacifica (Grunow) Petit 1888: 131

Lit. : Petit, P. (1888). Diatomées recoltées dans le voisinage du Cap Horn. In: Mission scientifique du Cap Horn 1882 - 1883, Vol. 5, Botanique. (Hariot, P., Petit, P., Müller d'Argovie, J., Bescherelle, E., Massalongo, C. & Franchet, A. Eds), pp. 111-140. Paris: Gauthier-Villas.

Observation : Valve shape is elongate with heteropolar. Valve is 8 ㎛ long and 2.7 ㎛ wide. The sternum is narrow along the apical axis of the valve. Large areolae appear near the valve margin. Areolae appear alternately around the sternum. Areolae are large, transversely elongated. Areolae decreases in size toward apices. The density of striae is 15 in 10 ㎛.

Opephora cf. *martyi* Héribaud-Joseph

Lit. : Héribaud-Joseph, Frère [J.-B. C.] (1902). Les Diatomées Fossiles d'Auvergne. pp. 5-79, pl. 7-8. Paris: Libraire des Sicences Naturelles.

Observation : Valve shape is elongate with heteropolar. Valve is 7.3-14.7 ㎛ long and 3.3-5.3 ㎛ wide. The sternum is narrow along the apical axis of the valve. Areolae appear alternately around the sternum. Large areolae appear near the valve margin. Areolae are large, transversely elongated. Areolae decreases in size toward apices. The density of striae is 12 in 10 ㎛.

Opephora cf. *mutabilis* Sabbe & Wyverman, nom. inval.

Lit. : Sabbe, K. & Vyverman, W. (1995). Taxonomy, morphology and ecology of some widespread representatives of the diatom genus Opephora. European Journal of Phycology 30: 235-249, 79 figs, 2 tables.

Observation : Valve shape is narrow elongate with heteropolar. Valve is 15.3-18.7 ㎛ long and 3.3 ㎛ wide. The sternum is narrow along the apical

axis of the valve. Areolae appear alternately around the sternum. Large areolae appear near the valve margin. Areolae are large, transversely elongated. Areolae decreases in size toward apices. The density of striae is 9-12 in 10 ㎛.

Opephora sp. 1

Observation : Valve shape is wide elongate with heteropolar. Valve is 8 ㎛ long and 2.7 ㎛ wide. The sternum is wide along the apical axis of the valve. Large areolae appear near the valve margin. Areolae are large, transversely elongated. Areolae appear alternately around the sternum. Areolae decreases in size toward apices. The density of striae is 15 in 10 ㎛.

Opephora sp. 2

Observation : Valve shape is narrow elongate with heteropolar. Valve is 13.3 ㎛ long and 2.7 ㎛ wide. The sternum is wide along the apical axis of the valve. Areolae appear alternately around the sternum. Large areolae appear near the valve margin. Areolae appear alternately around the sternum. The density of striae is 18 in 10 ㎛.

Staurosira Ehrenberg, 1843

Holotype Species : *Staurosira construens* Ehrenberg

Staurosira construens var. *binodis* (Ehrenberg) Edlund, nom. inval.

Bas. : *Fragilaria binodis* Ehrenberg

Lit. : Edlund, M.B. (1994). Additions and confirmations to the algal flora of Itasca State Park. II. Diatoms from Chambers Creek. Journal of the Minnesota Academy of Sciences 59(1): 10-21.

Observation : Valve shape is weakly bi-undulate. Valve is 9.3-18 ㎛ long and 4-4.7 ㎛ wide. Areolae shape is lineolae. In LM, Striae seems to be connected in one line and parallel. The density of Striae is 15-18 in 10 ㎛. Sternum Appears wider on the vertical axis.

Surirella Turpin, 1828

Holotype Species : *Surirella striatula* Turpin

Surirella cf. *oestrupii*

Observation : Valve shape is heteropolar, one side(headpole) is round and the other(footpole) is cuneate. Valve is 17.3 ㎛ long and 6.7 ㎛ wide. A Narrow hyaline appears at center of valve in axial direction. There are transapical depressions between porcae along the apical axis, forming a distinct corrugated pattern.

Tabularia (Kützing) D.M.Williams & Round, 1986

Holotype Species : *Tabularia barbatula* (Kützing) D.M.Williams & Round

Tabularia fasciculata (C.Agardh) D.M.Williams & Round

Bas. : Diatoma *fasciculata* C.Agardh

Lit. : Williams, D.M. & Round, F.E. (1986). Revision of the genus Synedra Ehrenb. Diatom Research 1(2): 313-339.

Observation : The valve shape is linear and elongate. Valve is 50.7 ㎛ long and 5.3 ㎛ wide. The density of Striae is 21 in 10 ㎛ and parallel. No central area, wide sternum on vertical axis and the sternum becomes narrower toward the apical.

Trachysphenia P.Petit, 1877

Holotype Species : *Trachysphenia australis* P.Petit

Trachysphenia cf. *acuminata* Peragallo

Lit. : Tempère, J. & Peragallo, H. (1910). Diatomées du Monde Entier, Edition 2, 30 fascicules. Fascicule 13-16. pp. 209-256. Arcachon, Gironde: Chez J. Tempère.

Observation : The valve shape elongate, and becomes narrower toward the end Valve is 10 ㎛ long and 3.3 ㎛ wide. No central area. The density of Striae is 21 in 10 ㎛ and parallel. Sternum in the central area is expanded. Sternum in the central area is a little expanded. Areolae is inconspicuous.

Trachysphenia cf. *australis* P. Petit

Lit. : Petit, P. (1877). Catalogue des Diatomées. In: Les fonds de la mer. Étude sur les particularités nouvelles des régions sous-marines. Tome Troisième contenant environ 115 figures hors texte, représentant 75 formes animales ou végétales inédites foraminifères, mollusques, diatomées) et plus de 300 pages de texte. 1875-1879. (Folin, L. De & Périer, L Eds), pp. 168-198. Paris: Savy, Libraire-Éditeur.

Observation : The valve shape elongate, and becomes narrower toward the end. Valve is 16-18 ㎛ long and 36-6.7 ㎛ wide. No central area. The density of Striae is 9 in 10 ㎛ and parallel. Areolae is big. Striae is uniseriate.

Trachysphenia sp. 1

Observation : Valve shape is heteropolar. Like a drop of water, one side(headpole) is round and the other(footpole) is cuneate. Valve is 13.3 ㎛ long and 4 ㎛ wide. No central area. The density of Striae is 12 in 10 ㎛ and parallel. Areolae is big. Striae is uniseriate.

Trachysphenia sp. 2

Observation : The valve shape is elongate with undulate margins, and asymmetrical left and right. Valve is 10.7 ㎛ long and 5.3 ㎛ wide. No central area. The density of Striae is 12 in 10 ㎛. Areolae is big. Striae is uniseriate.

RAPHIDOINEAE

Achnanthes Bory, 1822

Holotype Species : *Achnanthes adnata* Bory

Achnanthes sancti-paulii (Heiden in Heiden & Kolbe) Kobayasi & Sawatari

Lit. : Heiden, H. & Kolbe, R.W. (1928). Die Marinen Diatomeen der Deutschen Südpolar-Expedition, 1901-1903. In: Deutsche Sudpolar-Expedition, 1901-1903, herausgegeben von Erich von Drygalski. Vol. VIII, Botanik (no. 5). Walter de Gruyter & Co., Berlin und Leipzig, pp. 447-715, pls. 31-43.

Observation : The valve shape is elliptical and linear with rounded apices. Valve is 31.3 ㎛ long and 9.3 ㎛ wide. Areolae are large, square or round. The density of Striae is 9 in 10 ㎛. Transverse areolae is 12 in 10 ㎛.

Achnanthes cf. _brevipes_ C.Agardh, nom. illeg.

Lit. : Agardh, C.A. (1824). Systema algarum. pp. [i]-xxxvii, [1]-312. Lundae [Lund]: Literis Berlingianis [Berling].

Observation : The valve shape is elliptical and linear with rounded apices. Valve is 10.7 ㎛ long and 5.3 ㎛ wide. Areolae is large and round. Raphe is straight. Central raphe ending is simple. The density of Striae is 12 in 10 ㎛. Fascia appears transverse in the Central area.

Achnanthes sp. 1

Observation : The valve shape is elliptical and linear with pointed apices. Valve is 26 ㎛ long and 8.7 ㎛ wide. Areolae are large, square or round. The density of Striae is 9 in 10 ㎛. Transverse areolae is 12 in 10 ㎛. Narrow Sternum Appears to One Side of Valve.

Achnanthes sp. 2

Observation : Valves have different shapes on both sides with apices bend in different directions. Valve is 32-37.3 ㎛ long and 14-15.3 ㎛ wide. Raphe is straight. Central raphe ending is simple and expanded like small pore. Terminal raphe endings bend in different directions. Areolae are large, round. Transverse areolae is 18-21 in 10 ㎛. The density of Striea is 12-15 in 10 ㎛. Rapheless valves extend slightly in one direction from the center area.

Planothidium Round & L.Bukhtiyarova, 1996

Holotype Species : *Planothidium lanceolatum* (Brébisson ex Kützing) Lange-Bertalot

Planothidium delicatulum (Kützing) Round & Bukhtiyarova

Bas. : *Achnanthidium delicatulum* Kützing

Lit. : Round, F.E. & Bukhtiyarova, L. (1996). Four new genera based on Achnanthes (Achnanthidium) together with a re-definition of Achnanthidium. Diatom Research 11(2): 345-361.

Observation : Valve shape is lanceolate and has two type valve. One is raphe valve, another is rapheless valve. Valve is 14-19.3 ㎛ long and 6-6.7 ㎛ wide. Areolae is inconspicuous. Rapheless valve appears wide sternum. Raphe of raphe valve is straight. Central raphe ending is simple. Striae is irregular, the density of striae is 9-12 in 10 ㎛.

Planothidium engelbrechtii (Cholnoky) Round & Bukhtiyarova

Bas. : *Achnanthes engelbrechtii* Cholnoky

Lit. : Round, F.E. & Bukhtiyarova, L. (1996). Four new genera based on *Achnanthes* (Achnanthidium) together with a re-definition of Achnanthidium. Diatom Research 11(2): 345-361.

Observation : Valve shape is lanceolate and has two type valve. One is raphe valve, another is rapheless valve. Valve is 14.7-20 ㎛ long and 6.7-8 ㎛ wide. Areolae is inconspicuous. In the central area of the valve, the transverse Sternum is thick. Striae is radial, the density of striae is 15 in 10 ㎛.

Planothidium graum

Observation : Valve shape is lanceolate and has two type valve. One is raphe valve, another is rapheless valve. The raphe ending of raphe valve is simple and expanded like small pore. Valve is 10-10.7 ㎛ long and 5.3-6 ㎛ wide.

The density of Striea is 12 in 10 ㎛.

Planothidium lilljeborgei (Grunow) Witkowski, Lange-Bertalot & Metzeltin

Bas. : *Achnanthes lilljeborgei* Grunow

Lit. : Witkowski, A., Lange-Bertalot, H. & Metzeltin, D. (2000). Diatom flora of marine coasts I. Iconographia Diatomologica 7: 1-925, 219 pls.

Observation : Valve shape is elongate with apices narrowed. Valve is 11.3 ㎛ long and 6 ㎛ wide. Areolae is inconspicuous. The sternum of the Rapheless valve extends widely in the center area. Striae is radial, the density of striae is 12 in 10 ㎛.

Planothidium pericavum (J.R.Carter) Lange-Bertalot

Bas. : *Achnanthes pericava* J.R.Carter

Lit. : Lange-Bertalot, H. (1999). Neue Kombinationen von Taxa aus Achnanthes Bory (sensu lato). Iconographia Diatomologica 6: 270-283.

Observation : Valve shape is elliptical and linear. Valve is 12 ㎛ long and 2.7 ㎛ wide. Areolae is inconspicuous. Striae is parallel, the density of striae is 15 in 10 ㎛.

Planothidium sp. 1

Observation : Valve shape is elliptical and with apices narrowed. Valve is 6.7-8.7 ㎛ long and 3.3-4 ㎛ wide. Areolae is inconspicuous. Striae is parallel, the density of striae is 15-18 in 10 ㎛.

Planothidium sp. 2

Observation : Valve shape is elliptical and with apices narrowed. Valve is 20 ㎛ long and 10 ㎛ wide. Areolae is inconspicuous. Raphe is straight. Central raphe ending is simple and expanded like small pore. Striae is radial, the density of striae is 12 in 10 ㎛.

Planothidium sp. 3

Observation : Valve shape is elliptical and with apices narrowed. Valve is 20 ㎛ long and 10 ㎛ wide. Areolae is inconspicuous. Raphe is straight. Central raphe ending is simple and expanded like small pore. Striae is radial, the density of striae is 15 in 10 ㎛.

Staurophora Mereschkowsky, 1903, nom. cons.

Holotype Species : *Staurophora amphioxys* (W.Gregory) D.G.Mann

Staurophora cf. *salina* (W.Smith) Mereschkowsky

Bas. : *Stauroneis salina* W.Smith

Lit. : Mereschkowsky, C. (1903). Über Placoneis, ein neues Diatomeen-Genus. Beihefte zum Botanischen Centralblatt 15(1): 1-30, pl. 1.

Observation : Valve shape is oval and elongate, lanceolate. The axial area is narrow. Valve is 34.7-51.3 ㎛ long and 6.7-9.3 ㎛ wide. Raphe is straight. Central raphe ending is simple. Raphe-Sternum is narrow. Fascia appears transverse in the Central area. The width of the fascia is equal to or greater than the spacing of the Central raphe endings. Striae is almost parallel in the central region and radial to both apices. The density of Striae is 18-21 in 10 ㎛. In LM, areolae is inconspicuous.

Staurophora sp. 1

Observation : Valve shape is oval and elongate, lanceolate. Valve is 60 ㎛ long. Raphe is straight. Central raphe ending is simple. Fascia appears transverse in the Central area. The width of the fascia is equal to or greater than the spacing of the Central raphe endings. Striae is almost parallel in the central region and radial to both apices. The density of Striae is 18 in 10 ㎛. In LM, areolae are fine, leading to mantle.

Staurophora sp. 2

Observation : Valve shape is oval and elongate, lanceolate. Valve is 24 ㎛ long and 6 ㎛ wide. Raphe is straight. Central raphe ending is simple. Fascia appears transverse in the Central area. The width of the fascia is greater than the spacing of the Central raphe endings. Striae is almost parallel in the central region and radial to both apices. The density of Striae is 27 in 10 ㎛.

In LM, areolae are fine and not observed.

Staurophora sp. 3

Observation : Valve shape is narrow-elongate. Valve is 24 ㎛ long and 6 ㎛ wide. Raphe is straight. Central raphe ending is simple. Fascia appears transverse in the Central area. The width of the fascia is greater than the spacing of the Central raphe endings. Striae is weakly radial. The density of Striae is 18 in 10 ㎛. In LM, areolae are fine and not observed.

Nitzschia Hassall, 1845, nom. cons.

Holotype Species : *Nitzschia elongata* Hassal

Nitzschia adducta Hustedt

Lit. : Hustedt, F. (1955). Marine littoral diatoms of Beaufort, North Carolina. Bulletin Duke University Marine Station 6: 1-67, incl.16 pls.

Observation : The valve shape is elliptical with pointed apices. Valve is 24.7 ㎛ long and 7.3 wide. The density of Striae is 18 in 10 ㎛. In LM, areolae are round, but not clearly observed.

Nitzschia alpina Hustedt

Lit. : Hustedt, F. (1943). Die Diatomeenflora einiger Hochgebirgsseen der Landschaft Davos in den schweizer Alpen. Internationale Revue der gesamten Hydrobiologie und Hydrographie 43: 124-197, 225-280.

Observation : Valve shape is linear with narrower towards apices. Valve is 10-22 ㎛ long and 2.7 ㎛ wide. Fibulae are distinguished, their density is 12 in 10 ㎛. The density of Striae is 24 in 10 ㎛. In LM, areolae is inconspicuous.

Nitzschia amphibia Grunow

Lit. : Grunow, A. (1862). Die Österreichischen Diatomaceen nebst Anschluss einiger neuen Arten von andern Lokalitäten und einer kritischen Uebersicht der bisher bekannten Gattungen und Arten. Verhandlungen der kaiserlich-königlichen zoologisch-botanischen Gesellschaft in Wien 12: 315-472 [Abt 1], 545-588 [Abt. 2], 7 pls.

Observation : Valve shape is linear with narrower towards apices. Valve is 29.3 ㎛ long and 4 ㎛ wide. Fibulae are distinguished, their density is 9 in 10 ㎛. The density of Striae is 18 in 10 ㎛. In LM, areolae is inconspicuous.

Nitzschia desertorum Hustedt

Lit. : Hustedt, F. (1949). Diatomeen von Sinai-Halbinsel und aus dem Libanon Gebiet. Hydrobiologia 2: 24-55.

Observation : Valve shape is elliptical with apices bent slightly to one side. Valve is 18-19.3 ㎛ long and 3.3-4 ㎛ wide. Fibulae are distinguished, their density is 15 in 10 ㎛. The density of Striae is 30 in 10 ㎛. In LM, areolae is inconspicuous.

Nitzschia granulata Grunow

Lit. : Cleve, P. T. & Grunow, A. (1880). Beiträge zur Kenntniss der arctischen Diatomeen. Kongliga Svenska Vetenskaps-Akademiens Handlingar 17(2): 1-121, 7 pls.

Observation : The valve shape is oval and elongate. Valve is 50 ㎛ long and 4 ㎛ wide. The density of Striae is 9 in 10 ㎛. In LM, areolae are large, circular. Striae does not show a typical pattern. Transverse areolae is 9 in 10 ㎛.

Nitzschia hungarica Grunow

Lit. : Grunow, A. (1862). Die Österreichischen Diatomaceen nebst Anschluss einiger neuen Arten von andern Lokalitäten und einer kritischen Uebersicht der bisher bekannten Gattungen und Arten. Verhandlungen der kaiserlich-königlichen zoologisch-botanischen Gesellschaft in Wien 12: 315-472 [Abt 1], 545-588 [Abt. 2], 7 pls.

Observation : The valve shape is elliptical and linear with pointed apices. The valve also narrows slightly in the center area. Valve is 24-43.3 ㎛ long and 5.3-6 ㎛ wide. Fibulae are distinguished, their density is 15-18 in 10 ㎛. The density of Striae is 18 in 10 ㎛. In LM, areolae is inconspicuous. When LM is observed, thick hyaline appears in the center of the valve along the vertical axis.

Nitzschia lorenziana Grunow

Lit. : Cleve, P.T. & Möller, J.D. (1879). Diatoms. Part IV, No.169-216. . Upsala: Esatas Edquists Boktryckeri.

Observation : The valve shape is linear and the apices are very narrow and bent in one direction. Valve is 50 ㎛ long and 4 ㎛ wide. Fibulae are distinguished, their density is 12 in 10 ㎛. The density of Striae is 21 in 10 ㎛. In LM, areolae is inconspicuous.

Nitzschia panduriformis W. Gregory

Lit. : Gregory, W. (1857). On new forms of marine Diatomaceae found in the Firth of Clyde and in Loch Fyne, illustrated by numerous figures drawn by R.K. Greville, LL.D., F.R.S.E. Transactions of the Royal Society of Edinburgh 21: 473-542, pl. 9-14.

Observation : The valve shape is wide elliptical and linear with pointed apices. The valve also narrows slightly in the center area. Valve is 24-43.3 ㎛ long and 5.3-6 ㎛ wide. The density of Striae is 15 in 10 ㎛. In LM, areolae are large, round. Transverse areolae is 15 in 10 ㎛. Striae does not show a typical pattern.

Nitzschia cf. *miserabilis*

Lit. : Cholnoky, B.J. (1963). Beiträge zur Kenntnis des marinen Litorals von Südafrika. Botanica Marina 5: 38-83.

Observation : The valve shape is elliptical and linear with pointed apices. Valve is 29.3-34 ㎛ long and 4-47 ㎛ wide. In LM observed, areolae and Striae are hard to see. Fibulae spacing is large in central region, but narrower toward apices.

Nitzschia cf. solita Hustedt

Lit. : Hustedt, F. (1953). Diatomeen aus der Oase Gafsa in Südtunesien, ein

Beitrag zur Kenntnis der Vegetation afrikanischer Oasen. Archiv für Hydrobiologie 48(2): 145-153.

Observation : Valve shape is elliptical with narrower towards apices. Valve is 8.7-13.3 ㎛ long and 2.7-4 ㎛ wide. Fibulae are distinguished, their density is 21 in 10 ㎛. The density of Striae is 36 in 10 ㎛. In LM, areolae is inconspicuous.

Nitzschia sp. 1

Observation : The valve shape is elliptical and linear with pointed apices. Valve is 31.3-39.3 ㎛ long and 6-6.7 ㎛ wide. The density of Striae is 33 in 10 ㎛. Striae spacing is very tight. In LM, areolae is inconspicuous. Fibulae are distinguished, their density is 15 in 10 ㎛.

Nitzschia sp. 2

Observation : The valve shape is wide elliptical and linear with pointed apices. Valve is 29.3 ㎛ long and 6 ㎛ wide. Observed from In LM, areolae and Striae are difficult to observe. In LM observations, irregular lines are seen in the transverse direction.

Nitzschia sp. 3

Observation : The valve shape is narrow elliptical and linear with pointed apices. Valve is 39.3 ㎛ long and 5.3 ㎛ wide. he density of Striae is 33 in 10 ㎛. Striae spacing is very tight. Fibulae are distinguished, their density is 15 in 10 ㎛.

Tryblionella W. Smith, 1853

Holotype Species : *Tryblionella acuminata* W.Smith

Tryblionella apiculata W. Gregory

Lit. : Gregory, W. (1857). On the post-Tertiary diatomaceous sand of Glenshira. Part II. Containing an account of a number of additional undescribed species. Transactions of the Microscopical Society of London 5: 67-88, pl. 1.

Observation : The valve shape is wide elliptical and linear with pointed apices. The valve also narrows slightly in the center area. Valve is 56-68 ㎛ long and 7.3-10 ㎛ wide. Fibulae are distinguished, their density is 15-18 in 10 ㎛. The density of Striae is 12 in 10 ㎛. In LM, areolae is inconspicuous. When LM is observed, thick hyaline appears in the center of the valve along the vertical axis.

Tryblionella hungarica (Grunow) Frenguelli

Lit. : Frenguelli, J. (1942). XVII. Contribución al conocimiento de las diatomeas Argentinas. Diatomeas del Neuguén (Patagonia). . Revista del Museo de La Plata (Nueva Serie) 5(Sección Botánica 20): 73-219, 12 pls.

Bas. : *Nitzschia hungarica* Grunow

Observation : The valve shape is elliptical and linear with pointed apices. The valve also narrows slightly in the center area. Valve is 90.7 ㎛ long and 7.3 ㎛ wide. Fibulae are distinguished, their density is 12 in 10 ㎛. The density of Striae is 18 in 10 ㎛. In LM, areolae is inconspicuous. In LM observations, there appears to be a difference in height of the valve along the longitudinal axis.

Berkeleya Greville, 1827

Holotype Species : *Berkeleya fragilis* Greville

Berkeleya rutilans (Trentepohl ex Roth) Grunow

Bas. : *Conferva rutilans* Trentepohl ex Roth

Lit. : Grunow, A. (1880). Vorlaufige Bemerkungen zu einer systematischen Anordung der Schizonema- und Berkeleya-Arten, mit Bezug auf die in Van Heurck's Diatomeenflora von Belgien veröffentlichten Abbildungen der Frusteln auf Taf. XV, XVI und XVII. [Part] II. Botanisches Centralblatt 4(48): 1585-1598.

Observation : The valve shape is elliptical and linear with round apices. Valve is 43.3 ㎛ long and 4.7 ㎛ wide. Raphe bends slightly and breaks along the way without going to the central area. Central raphe ending is deflected in the same direction. Raphe breaks in the middle, but hyaline appears between the Central raphe endings. Observed from In LM, areolae and Striae are difficult to observe.

Lunella P. Snoeijs, 1996

Holotype Species : *Lunella bisecta* P.Snoeijs

Lunella sp.

Observation : Valve shape is elliptical and linear. Valve is 18.7-28.7 ㎛ long and 5-5.3 ㎛ wide. Areolae is not clearly observed under the microscope. Raphe is straight. Central raphe ending is simple and expanded like small pore. Central raphe ending area extends horizontally. Striae is nearly parallel. The density of Striae is 9-12 in 10 ㎛. apices.

Amphora Ehrenberg ex Kützing, 1844

Holotype Species : *Amphora ovalis* (Kützing) Kützing

Amphora arenicola Grunow ex Cleve

Lit. : Cleve, P.T. (1895). Synopsis of the naviculoid diatoms. Part II. Kongliga Svenska Vetenskapsak Akademiens Handlingar 27(3): 1-219, 4 pls.

Observation : Valve shape is semi-lanceolate and arched dorsal margin. Valve is 18.7-34.7 ㎛ long and 3.3-5.3 ㎛ wide. Valve At the bottom around Raphe, areolae are arranged in two or three rows. Central raphe ending is deflected in the same direction. In LM, areolae is seem pore. Areolae is 12-15 in 10 ㎛. Narrow hyaline space runs from the central raphe ending area to the ventral margin.

Distribution : *A. arenicola* is marine and brackish water species (Witkowski et al,. 2000). In Korea, this species has been reported in Saemangeum tidal flats (Park, 2012).

Amphora costata W. Smith

Lit. : Smith, W. (1853). A synopsis of the British Diatomaceae; with remarks on their structure, function and distribution; and instructions for collecting and preserving specimens. The plates by Tuffen West. In two volumes. Vol. 1. pp. [i]-xxxiii, 1-89, pls I-XXXI. London: John van Voorst, Paternoster Row.

Observation : Valve shape is semi-lanceolate and rostrate apices. Valve is 18-25.3 ㎛ long and 3.3-4 ㎛ wide. In LM, Raphe is located near the ventral margin. Also in LM areolae is inconspicuous. The density of Striae is 15-16.5 at 10 ㎛.

Amphora helenensis Giffen

Lit. : Giffen, M.H. (1973). Diatoms of the marine littoral of Steenberg's Cove in St. Helena Bay, Cape Province, South Africa.. Botanica Marina 16(1): 32-48.

Observation : Valve shape is semi-lanceolate. Valve is 12.7-16.7 ㎛ long and 3.3-4 ㎛ wide. Striae is parallel in the central region and radial to both apices. In LM, Raphe is located near the ventral margin and areolae is inconspicuous. The density of Striae is 15-21 at 10 ㎛.

Amphora holsatica Hustedt

Lit. : Hustedt, F. (1925). Bacillariales aus den Salzgewässern bei Oldesloe in Holstein. Mitteilungen der geographischen Gesellschaft und der Naturhistorischen Museums in Lubeck, zweite Reihe 30: 84-121.

Observation : Valve shape is semi-lanceolate and straight apices. Valve is 26.7 -44.7 ㎛ long and 6-7.3 ㎛ wide. In LM, Areolae is seem small pore and one row of areolae just under raphe. Raphe is straight and sometimes Central raphe ending is deflected in the same direction. The density of dorsal margin Striae is 9-12 in 10 ㎛ and ventral margin Striae is 12-15 in 10 ㎛. The density of transverse areolae is 15-21 in 10 ㎛. Striae is parallel in the central region and radial to both apices. Below the central raphe ending is a hyaline space with no areolae to the ventral margin.

Distribution : This is a brackish species. Also living in marine waters - (11 Oct 2010) - Salvador Valenzuela Miranda. In Korea, this species has been reported in Pohang (Wang et al., 2014. as *Halamphora holsatica*).

Amphora maletractata var. *constricta* (H.Heiden) Simonsen

Bas. : *Amphora interrupta* var. *constricta* H.Heiden

Lit. : Simonsen, R. (1992). The diatom types of Heinrich Heiden in Heiden & Kolbe. Bibliotheca Diatomologica 24: 1-99.

Observation : Valve shape is semi-lanceolate and ventral margin irregular. Valve is 20.8 ㎛ long and 5.3 ㎛ wide. Raphe is straight and Central raphe ending is deflected in the same direction. In LM, Areolae is seem pore and one row of areolae just above raphe.

Distribution : *A. maletractata* var. *constricta* is marine and brackish species (Witkowski et al., 2000). In Korea, this species has been reported in Saemangeum tidal flats (Park, 2012).

Amphora richardiana Cholnoky

Lit. : Cholnoky, B.J. (1968). Die Diatomeenassoziationjen der Santa Lucía Lagune in Natal (Südafrika). Botanica Marina 11(suppl.): 1-121.

Observation : Valve shape is semi-lanceolate. Valve is 26.7-34.7 ㎛ long and 6-7.3 ㎛ wide. Raphe is straight and sometimes central raphe ending is expanded like pore. The density of transverse areolae is 15-21 in 10 ㎛. Striae is parallel in the central region and radial to both apices. The density of Striae is 13.5-15 in 10 ㎛.

Amphora cf. *proteus* W. Gregory

Lit. : Gregory, W. (1857). On new forms of marine Diatomaceae found in the Firth of Clyde and in Loch Fyne, illustrated by numerous figures drawn by R.K. Greville, LL.D., F.R.S.E. Transactions of the Royal Society of Edinburgh 21: 473-542, pl. 9-14.

Observation : Valve shape is semi-lanceolate and straight apices. Valve is 20.7 ㎛ long and 4 ㎛ wide. In LM, Raphe is straight and Central raphe ending is deflected in the same direction. The density of dorsal margin and ventral margin Striae is 15 at 10 ㎛. In LM, Areolae is inconspicuous.

Amphora cf. *terroris* Ehrenberg

Lit. : Ehrenberg, C.G. (1853). Über einige neue Materialien zur Übersicht des kleinsten Lebens. Bericht über die zur Bekanntmachung geeigneten Verhandlungen der Königlich-Preussischen Akademie der Wissenschaften zu Berlin 1853: 505-533.

Observation : Valve shape is semi-lanceolate and straight apices. Valve is 12.7

㎛ long and 4 ㎛ wide. In LM, Raphe is straight and Central raphe ending is deflected in the same direction. The density of dorsal margin and ventral margin Striae is 18 at 10 ㎛.

Distribution : *A. terroris* is marine and brackish species (Witkowski et al., 2000). In Korea, this species has been reported in Jeju (Wang et al., 2014. as *Halamphora terroris*).

Amphora sp. 1

Observation : Valve shape is semi-lanceolate. In LM, The raphe is close to the dorsal margin. Valve is 16.7-18.7 ㎛ long and 2.7-3.3 ㎛ wide. In LM, the ventral margin area seems to occupy nearly 80%. Also areolae is inconspicuous.

Amphora sp. 2

Observation : Valve shape is semi-lanceolate. In LM, the central part of the ventral margin is slightly convex and raphe is straight and sometimes central raphe ending is expanded like pore. Valve is 18-24 ㎛ long and 2.7-4.7 ㎛ wide. One row of areolae just under raphe. The density of Striae is 18-21 in 10 ㎛.

Amphora sp. 3

Observation : Valve shape is semi-lanceolate. In LM, the raphe is straight and sometimes central raphe ending is expanded like pore. Valve is 18-24 ㎛ long and 2.7-4.7 ㎛ wide. The density of Striae is 13.5-15 in 10 ㎛.

Amphora sp. 4

Observation : Valve shape is semi-lanceolate. Valve is 18-24 ㎛ long and 4-4.7 ㎛ wide. The density of Striae is 13.5-15 in 10 ㎛.

Amphora sp. 5

Observation : Valve shape is semi-lanceolate. Valve is 36.7 ㎛ long and 5.3 ㎛ wide. The density of Striae is 12 in 10 ㎛. In LM, Central raphe ending is deflected in the same direction.

Amphora sp. 6

Observation : Valve shape is semi-lanceolate. Valve is 12-13.5 ㎛ long and 4-4.5 ㎛ wide. The density of Striae is 12-13.5 in 10 ㎛. In LM, the raphe is straight and sometimes central raphe ending is expanded like pore. Striae clearly visible, but areolae inconspicuous.

Amphora sp. 7

Observation : Valve shape is semi-lanceolate. Valve is 30-33.3 ㎛ long and 4-6 ㎛ wide. The density of Striae is 18-19.5 in 10 ㎛. In LM, the raphe is straight.

Amphora sp. 8

Observation : Valve shape is semi-lanceolate. Valve is 32-28.7 ㎛ long and 5.3-6 ㎛ wide. The density of Striae is 16.5-18 in 10 ㎛. In LM, the raphe is straight and sometimes central raphe ending is expanded like pore.

Amphora sp. 9

Observation : Valve shape is semi-lanceolate. Valve is 32-28.7 ㎛ long and 5.3-6 ㎛ wide. The density of Striae is 16.5-18 in 10 ㎛. In LM, the raphe is straight and sometimes central raphe ending is expanded like pore. Also Striae and areolae are inconspicuous.

Amphora sp. 10

Observation : Valve shape is semi-lanceolate. Valve is 27.3 ㎛ long and 5.3 ㎛

wide. The density of Striae is 15 in 10 ㎛. Striae is parallel in the central region and radial to both apices.

Amphora sp. 11

Observation : Valve shape is semi-lanceolate with wide. Valve is 28 ㎛ long and 12 ㎛ wide. The density of areolae is 15 in 10 ㎛. The density of Striae is 12 in 10 ㎛. Striae is parallel in the central region and radial to both apices. In LM, the areolae is like small pore.

Amphora sp. 12

Observation : Valve shape is semi-lanceolate with wide. Valve is 37.3 ㎛ long and 7.3 ㎛ wide. In LM, the raphe is straight and central raphe ending is expanded like pore. The density of Striae is 15 in 10 ㎛.

Amphora sp. 13

Observation : Valve shape is semi-lanceolate with wide and rostrate apices. Valve is 37.3 ㎛ long and 7.3 ㎛ wide. In LM, Central raphe ending is deflected in the same direction. The density of Striae is 15 in 10 ㎛.

Catenula Mereschkowsky, 1903

Holotype Species : *Catenula pelagica* Mereschkowsky

Catenula sp.

Observation : Valve shape is learly dorsiventral, with narrow rostrate. Valve is 22 ㎛ long and 3.3 ㎛ wide. The density of Striae is 12 in 10 ㎛. Striae is weakly radial. In LM, areolae is inconspicuous. Raphe is located close to the ventral side and thick in LM.

Anorthoneis Grunow, 1868

Holotype Species : *Anorthoneis excentrica* (Donkin) Grunow

Anorthoneis sp. 1

Observation : Valve shape is wide oval. Valve is 15.3-21.3 ㎛ long and 12-16.7 ㎛ wide. Raphe is absent, the narrow Sternum is located in the middle of the valve in the longitudinal axis, and the Sternum extends in a circle in the center area. Areolae look like dots and have a narrow gap. Striae appear radial. The density of Striae is 2 in 10 ㎛.

Anorthoneis sp. 2

Observation : Valve shape is wide oval. Valve is 13.3 ㎛ long and 9.3 ㎛ wide. No sternum, but hyaline in the central region. Areolae are large, circular. Areolae extends to the valve margin, and the size of the areolae decreases as it approaches the valve margin. Striae appear radial. Valve margin The density of Striae is 15 in 10 ㎛.

Cocconeis Ehrenberg, 1836

Holotype Species : *Cocconeis scutellum* Ehrenberg

Cocconeis distans W. Gregory

Lit. : Gregory, W. (1855). On the post-Tertiary lacustrine sand containing diatomaceous exuviae from Glenshire near Inverary. Quarterly Journal of Microscopical Science 3: 30-43.

Observation : Valve shape is narrow oval with heterovalve. Valve is 15.3 ㎛ long and 8.7 ㎛ wide. Sternum of rapheless valve is wide. In LM, areolae appear round and small. And the spacing of the areolae is narrower from the center to the edges. Striae is radial. The density of Striae is 12 in 10 ㎛.

Cocconeis irregularis (P. Schulz) Witkowski

Bas. : *Cocconeis scutellum* var. *irregularis* P.Schulz

Lit. : Witkowski, A., Lange-Bertalot, H. & Metzeltin, D. (2000). Diatom flora of marine coasts I. Iconographia Diatomologica 7: 1-925, 219 pls.

Observation : Valve shape is wide oval with heterovalve. Valve is 16.7-20 ㎛ long and 10.7-14 ㎛ wide. Sternum of rapheless valve is narrow, areolae are large and look like a rectangle. Striae is radial. The density of Striae is 12 in 10 ㎛. Transverse areolae is 9 in 10 ㎛.

Cocconeis placentula

Lit. : Ehrenberg, C.G. (1838). Atlas von Vier und Sechzig Kupfertafeln ze Christian Gottfried Ehrenberg über Infusionsthierchen. pp. pls I-LXIV. Leipzig: Verlag von Leopold Voss.

Observation : Valve shape is wide oval with heterovalve. Valve is 26.7 ㎛ long and 15.3 ㎛ wide. Sternum of rapheless valve is narrow. Raphe is straight. Raphe-Sternum is narrow. Central raphe ending is simple and expanded like small pore. In LM, areolae of raphe valve appear round and

small, with density of transverse areolae is 21 in 10 ㎛. The areolae of the rapheless valve is in the form of a horizontal lineolae, with density of transverse areolae is 15 in 10 ㎛. Striae is radial. The density of rapheless valve Striae is 21 in 10 ㎛. The density of raphe valve Striae is 21 in 10 ㎛.

Cocconeis scutellum Ehrenberg

Lit. : Ehrenberg, C.G. (1838). Atlas von Vier und Sechzig Kupfertafeln ze Christian Gottfried Ehrenberg über Infusionsthierchen. pp. pls I-LXIV. Leipzig: Verlag von Leopold Voss.

Observation : Valve shape is wide oval with heterovalve. Valve is 18.7-26 ㎛ long and 11.3-16.7 ㎛ wide. Sternum of rapheless valve is narrow. Raphe is straight. Raphe-Sternum is narrow. A wide oval rim appears along the valve shape near the valve edge. In LM, areolae of raphe valve appear round and small. The areolae of the rapheless valve is larger and rounder than the areolae of the raphe valve. Striae is radial. The density of rapheless valve Striae is 15 in 10 ㎛. The density of raphe valve Striae is 18 in 10 ㎛.

Cocconeis cf. *sigillata* Riaux-Gobin & Al-Handal

Lit. : Riaux-Gobin, C., Compère, P. & Al-Handal, A.Y. (2011). Species of the Cocconeis peltoides group with a marginal row of unusual processes (Mascarenes and Kerguelen Islands, Indian Ocean). Diatom Research 26(4): 325-338.

Observation : Valve shape is wide oval with heterovalve. Valve is 14.7-17.3 ㎛ long and 9.3-12 ㎛ wide. Sternum of rapheless valve is narrow. And narrower Sternum appears in the vertical axis direction around the Sternum. In LM, areolae appear round and small. Striae is radial. The density of Striae is 15 in 10 ㎛.

Cocconeis sp. 1

Observation : Valve shape is wide oval with heterovalve. Valve is 14.7 ㎛ long and 12 ㎛ wide. Hyaline of rapheless valve is wide. The width of the hyaline is about one third of the valve area. In LM, the areolae of the rapheless valve is small and circular. Striae is radial. The density of rapheless valve Striae is 16 in 10 ㎛.

Cocconeis sp. 2

Observation : Valve shape is wide oval with heterovalve. Valve is 14.7 ㎛ long and 12 ㎛ wide. Hyaline of rapheless valve is wide. The width of the hyaline is about one third of the valve area. In LM, the areolae of the rapheless valve is small and circular. Striae is radial. The density of rapheless valve Striae is 16 in 10 ㎛.

Cocconeis sp. 3

Observation : Valve shape is wide oval with heterovalve. Valve is 14.7 ㎛ long and 12 ㎛ wide. Hyaline of rapheless valve is wide. The width of the hyaline is about one third of the valve area. In LM, the areolae of the rapheless valve is small and circular. Striae is radial. The density of rapheless valve Striae is 16 in 10 ㎛.

Cocconeiopsis Witkowski, Lange-Bertalot & Metzeltin, 2000

Holotype Species : Cocconeiopsis orthoneoides (Hustedt) Witkowski, Lange-Bertalot & Metzeltin

Cocconeiopsis patrickae

Bas. : Cocconeis patrickiae Hustedt

Lit. : Witkowski, A., Lange-Bertalot, H. & Metzeltin, D. (2000). Diatom flora of marine coasts I. Iconographia Diatomologica 7: 1-925, 219 pls.

Observation : Valve shape is wide oval. Valve is 35.3 ㎛ long and 20 ㎛ wide. Raphe is straight. Raphe-Sternum is narrow. Central raphe ending is expanded like pore. Striae is parallel in the central region and radial to both apices. The density of Striae is 15 in 10 ㎛. In LM, areolae are large, round. Transverse areolae is 15 in 10 ㎛.

Cocconeiopsis sp.

Observation : Valve shape is wide oval. Valve is 16 ㎛ long and 8.7 ㎛ wide. Raphe is straight. Raphe-Sternum is narrow. Central raphe ending appears thickened. Striae is parallel in the central region and radial to both apices. The density of Striae is 18 in 10 ㎛. In LM, areolae are large and round, looking like a dot. Transverse areolae is 21 in 10 ㎛.

Cymbella C.Agardh, 1830, nom. et typ. cons.

Holotype Species : *Cymbella cymbiformis* C.Agardh

Cymbella affinis Krammer

Lit. : Kützing, F.T. (1844). Die Kieselschaligen Bacillarien oder Diatomeen. pp. [i-vii], [1]-152, pls 1-30. Nordhausen: zu finden bei W. Köhne.

Observation : Valve shape is dorsiventral with narrow rostrate. Valve is 31.3-38.7 ㎛ long and 10-12.7 ㎛ wide. Central raphe ending is simple and curve to the ventral side. One stigma appears on ventral side between central raphe endings. The density of areolae is 18 in 10 ㎛. The density of Striae is 9-12 in 10 ㎛.

Luticola D.G.Mann, 1990

Holotype Species : *Luticola mutica* (Kützing) D.G.Mann

Luticola sp

Observation : Valve shape is ellipticate. Valve is 11.3 ㎛ long and 4.7 ㎛ wide. Raphe is straight. Central raphe ending is simple and expanded like small pore. In LM, Areolae is inconspicuous. Hyaline is wider in the horizontal direction from the center.

Diploneis Ehrenberg ex Cleve, 1894

Holotype Species : *Diploneis didyma* (Ehrenberg) Ehrenberg

Diploneis aestuarii Hustedt

Lit. : Hustedt, F. (1939). Die Diatomeenflora des Küstengebietes der Nordsee vom Dollart bis zur Elbemündung. I. Die Diatomeenflora in den Sedimenten der unteren Ems sowie auf den Watten in der Leybucht, des Memmert und bei der Insel Juist. Adhandlungen des Naturwissenschaftlichen Verein zu Bremen 31(2/3): 571-677.

Observation : Valve shape is elongate, center area slightly inward. Valve is 12.7 ㎛ long and 6 ㎛ wide. Raphe was not observed in LM, but Narrow hyaline appeared along raphe. Striae is parallel in the central region and radial to both apices. Areolae is inconspicuous. The density of Striae is 15 in 10 ㎛.

Diploneis litoralis (Donkin) Cleve

Bas. : *Navicula littoralis* Donkin

Lit. : Cleve, P.T. (1894). Synopsis of the naviculoid diatoms. Part I. Kongliga Svenska Vetenskapsakademiens Handlingar, series 4 26(2): 1-194, 5 pls..

Observation : The valve is rugged and irregular. Valve is 13.3 ㎛ long and 4.7 ㎛ wide. Areolae is radiate and curved striae formed by long prominent lineolae. In LM, it looks white in H shape. In LM, it looks white in H shape.

Diploneis notablils

Observation : Valve shape is elongate, with rounded apices. Valve is 17.3 ㎛ long and 8.7 ㎛ wide. Central raphe ending is deflected in the same direction and expanded like pore. The distance between the central raphe endings is 0.7 ㎛. Narrow longitudinal canal along raphe. Striae is weakly radial. The density of Striae is 18 in 10 ㎛. Striae is bisected by the Narrow hyaline on

the longitudinal axis.

Diploneis aff. *nitescens* (W.Gregory) Cleve

Bas. : *Navicula smithii* var. *nitescens* W.Gregory

Lit. : Cleve, P.T. (1894). Synopsis of the naviculoid diatoms. Part I. Kongliga Svenska Vetenskapsakademiens Handlingar, series 4 26(2): 1-194, 5 pls..

Observation : Valve shape is elliptic to panduriform and rounded apices. Valve is 20.7-37.3 ㎛ long and 10.7-15.3 ㎛ wide. Raphe is straight. Central raphe ending is deflected in the same direction and expanded like pore. Central raphe ending area slightly expanded. The distance between the central raphe endings is 1.3-2.7 ㎛. Narrow longitudinal canal along raphe. Striae is weakly radial. The density of Striae is 12 in 10 ㎛.

Diploneis cf. *stroemii* Hustedt

Lit. : Hustedt, F. (1937). Die Kieselalgen Deutschlands, Österreichs und der Schweiz unter Berücksichtigung der übrigen Länder Europas sowie der angrenzenden Meeresgebiete. Bd. VII: Teil 2: Liefrung 5. In: Rabenhorst's Kryptogamen Flora von Deutschland, Österreich und der Schweiz. (Anon. Eds), pp. 577-736. Leipzig: Akademische Verlagsgesellschaft m.b.h.

Observation : Valve shape is panduriform with rounded apices. Valve is 21.3 ㎛ long. The width is the narrowest at 5.3 ㎛ in the center area, the widest at 8.7 ㎛. Raphe is straight. Central raphe ending is simple. Wide hyaline along raphe. Striae is radial. Areolae is inconspicuous. The density of Striae is 15 in 10 ㎛.

Diploneis sp. 1

Observation : Valve shape is panduriform with rounded apices. Valve is 34.7 ㎛ long. The width is the narrowest at 9.3 ㎛ in the center area, the widest at 14.7 ㎛. Raphe is straight. Striae is radial. Areolae is big. The density of

Striae is 9 in 10 ㎛.

Diploneis sp. 2

Observation : Valve shape is panduriform with rounded apices. Valve is 21.3 ㎛ long. The width is the narrowest at 4.7 ㎛ in the center area, the widest at 7.3 ㎛. Raphe is straight. Striae is radial. Areolae is big. The density of Striae is 12 in 10 ㎛.

Entomoneis Ehrenberg, 1845

Holotype Species : *Entomoneis alata* (Ehrenberg) Ehrenberg

Entomoneis alata (Ehrenberg) Ehrenberg

Bas. : *Navicula alata* Ehrenberg

Lit. : Ehrenberg, C.G. (1845). Vorläufige zweite Mettheilung über die weitere Erkenntnifs der Beziehungen des kleinsten organischen Lebens zu den vulkanischen Massen der Erde. Bericht über die zur Bekanntmachung geeigneten Verhandlungen der Königlich-Preussischen Akademie der Wissenschaften zu Berlin 1845: 133-157.

Observation : In LM the valve shape is appears to be twisted about the apical axis. The cause of this observation in LM is the torsion of the keels. Valve is 63.3 ㎛ long and 12 ㎛ wide. The density of Striae is 18 in 10 ㎛. The areolae is less visible in LM.

Entomoneis sp.

Observation : In LM the valve shape is appears to be twisted about the apical axis. The cause of this observation in LM is the torsion of the keels. Valve is 20 ㎛ long and 5.3 ㎛ wide. The density of Striae is 21 in 10 ㎛. The areolae is less visible in LM.

Gomphonema Ehrenberg, 1832, nom. et typ. cons.

Holotype Species : *Gomphonema acuminatum* Ehrenberg

Gomphonema micropus Kützing

Lit. : Kützing, F.T. (1844). Die Kieselschaligen Bacillarien oder Diatomeen. pp. [i-vii], [1]-152, pls 1-30. Nordhausen: zu finden bei W. Köhne.

Observation : Valve shape is elongate, with apices are distinctly capitate. Valve is asymmetrical left and right. Valve is 20-26 ㎛ long and 5.3-6.7 ㎛ wide. Raphe is straight. Central raphe ending is simple. Striae is asymmetrical in the central region, with different Striae lengths on both sides. The Striae on the side with the stigmoid is long and the facing Striae appears very short on the edge. The density of Striae is 15 in 10 ㎛. Striae is almost parallel. In LM, areolae is inconspicuous.

Gomphonema sp. 1

Observation : Valve shape is claviform and heteropolar. Valve is asymmetrical left and right. Valve is 16.7 ㎛ long and 4.7 ㎛ wide. Raphe is straight. Central raphe ending is simple. Striae is asymmetrical in the central region, with different Striae lengths on both sides. The Striae on the side with the stigmoid is long and the facing Striae appears very short on the edge. The density of Striae is 15 in 10 ㎛. Striae is almost parallel. In LM, areolae is inconspicuous.

Gomphonema sp. 2

Observation : Valve shape is elongated lozenge that widens in the center and narrows toward the apices. Valve is asymmetrical left and right. Valve is 26 ㎛ long and 6.7 ㎛ wide. Raphe is straight. Central raphe ending is simple. Striae is asymmetrical in the central region, with different Striae lengths on both sides. The Striae on the side with the stigmoid is long and the facing

Striae appears very short on the edge. The density of Striae is 18 in 10 ㎛. Striae is weakly radial. In LM, areolae is inconspicuous.

Lyrella Karajeva [Karaeva], 1978

Holotype Species : *Lyrella lyra* (Ehrenberg) Karajeva

Lyrella cf. *hennedyi* (Gregory) D.G.Mann

Bas. : *Navicula hennedyi* W.Smith

Lit. : Round, F.E., Crawford, R.M. & Mann, D.G. (1990). The diatoms biology and morphology of the genera. pp. [i-ix], 1-747. Cambridge: Cambridge University Press.

Observation : Valve shape is wide elongate, with rounded apices. Valve is 24 ㎛ long and 19.3 ㎛ wide. The narrow H-shaped hyaline centers around the raphe. Under the microscope, the H-shaped hyaline appears to lead to apices. Raphe is straight. Central raphe ending is simple and expanded weakly. Areolae are small and tightly spaced. Striae is parallel in the central region and radial to both apices. The density of Striae is 18 in 10 ㎛.

Lyrella cf. *spectabilis* (Gregory) D.G.Mann

Bas. : *Navicula spectabilis* W.Gregory

Lit. : Round, F.E., Crawford, R.M. & Mann, D.G. (1990). The diatoms biology and morphology of the genera. pp. [i-ix], 1-747. Cambridge: Cambridge University Press.

Observation : Valve shape is wide elongate, with rounded apices. Valve is 25.3-29.3 ㎛ long and 14-18 ㎛ wide. The H-shaped hyaline centers around the raphe, and the H-shaped hyaline does not extend to the apices when observed in LM. Raphe is straight. Central raphe ending is simple and expanded like large pore. Terminal raphe ending bent in the same direction. Areolae are small and tightly spaced. Striae is radial. The density of Striae is 12 in 10 ㎛.

Moreneis J.Park, Koh & Witkowski, 2012

Holotype Species : *Moreneis coreana* J.Park, Koh & Witkowski

Moreneis hexagona J.Park, Koh & Witkowski

Lit. : Park, J., Koh, C.-H., Khim J.S., Ohtsuka, T. & Witkowski, A. (2012). Description of a new naviculoid diatom genus Moreneis gen. nov. (Bacillariophyceae) from sand flats in Korea. Journal of Phycology 48(1): 186-195.

Observation : Valve shape is elongate with narrow apices. Valve is 24 ㎛ long and 10 ㎛ wide. Central raphe ending bent strongly in the other direction and expanded like pore. Areolae is large and round. Terminal raphe ending bent in opposite direction to Central raphe ending. Striae is radial. The density of Striae is 15 in 10 ㎛.

Petroneis A.J.Stickle & D.G.Mann, 1990

Holotype Species : *Petroneis humerosa* (Brébisson ex W.Smith) Stickle & D.G.Mann

Petroneis marina (Gregory) D.G.Mann

Bas. : *Navicula spectabilis* W.Gregory

Lit. : Round, F.E., Crawford, R.M. & Mann, D.G. (1990). The diatoms biology and morphology of the genera. pp. [i-ix], 1-747. Cambridge: Cambridge University Press.

Observation : Valve shape is wide elongate, with narrower towards apices. Valve is 41.3 ㎛ long and 20.7 ㎛ wide. Raphe is straight. Central raphe ending ends in a T-shape and the hyaline extends in the transverse direction of the Central raphe ending area. Areolae is large and round. Transverse areolae is 9 in 10 ㎛. Striae is radial. The density of Striae is 12 in 10 ㎛.

Petroneis sp.

Observation : Valve shape is wide elongate, with narrower towards apices. Valve is 31.3 ㎛ long and 8.7 ㎛ wide. Raphe is straight. Central raphe ending is simple and expanded like small pore. Central raphe ending area extends wide in the horizontal direction. Areolae is large and round. Transverse areolae is 12 in 10 ㎛. Striae is radial. The density of Striae is 15 in 10 ㎛.

Caloneis Cleve, 1894

Holotype Species : *Caloneis amphisbaena* (Bory) Cleve

Caloneis crassa (Gregory) R.Ross

Bas. : *Navicula crassa* W.Gregory

Lit. : Hartley, B. [in collaboration with Ross, R. & Williams, D.M.] (1986). A check-list of the freshwater, brackish and marine diatoms of the British Isles and adjoining coastal waters. Journal of the Marine Biological Association of the United Kingdom 66(3): 531-610.

Observation : Valve shape is oval and elongate. Valve is 38.7-47.3 ㎛ long and 18-18.7 ㎛ wide. Raphe is straight. Raphe-Sternum is narrow but wider toward central area, the enlarged shape in the center is close to a circle. Central raphe ending is deflected in the same direction and expanded like pore. External polar raphe endings on both sides are strongly hooked in the same direction. Striae is radial. The density of Striae is 18-21 in 10 ㎛. In LM, areolae are fine and not observed.

Caloneis westii (W.Smith) Hendey

Bas. : *Navicula westii* W.Smith

Lit. : Hendey, N.I. (1964). An introductory account of the smaller algae of British coastal waters. Part V: Bacillariophyceae (diatoms). pp. [i]-xxii, 1-317. London: Ministry of Agriculture, Fisheries and Food, Fishery Investigations. Her Majesty's Stationery Office.

Observation : Valve shape is oval and elongate. Valve is 44-66.7 ㎛ long and 15.3-18 ㎛ wide. Raphe is straight. Raphe-Sternum is narrow but wider toward central area, maximum at central area. Central raphe ending is deflected in the same direction and expanded like pore. External polar raphe endings on both sides are strongly hooked in the same direction. Striae is radial. The density of Striae is 18-21 in 10 ㎛. In LM, areolae are fine and not observed.

Caloneis sp.

Observation : Valve shape is elongated. Valve is 19.3 ㎛ long and 4 ㎛ wide. Central area become wide, with shape rhombic. In LM, Areolae is inconspicuous. Central raphe ending is simple. Striae is radial. The density of Striae is 27 in 10 ㎛.

Chamaepinnularia Lange-Bertalot & Krammer, 1996

Holotype Species : *Chamaepinnularia vyvermanii* Lange-Bertalot & Krammer

Chamaepinnularia sp.

Observation : Valve shape is ellipticate. Valve is 13.3 ㎛ long and 6 ㎛ wide. Raphe is straight. Central raphe ending is simple and expanded like small pore. In LM, Areolae is inconspicuous. Hyaline is wider in the horizontal direction from the center.

Fogedia Witkowski, Lange-Bertalot, Metzeltin & Bafana, 1997

Holotype Species : *Fogedia giffeniana* (Foged) Witkowski, Lange-Bertalot, Metzeltin & Bafana

Fogedia densa Park, Khim, Koh & Witkowski

Lit. : Park, J., Khim, J.S., Ryu, J., Koh, C.-H. & Witkowski, A. (2013). An emended description of the genus Fogedia (Bacillariophyceae) with reports of four species new to science from a Korean sand flat. Phycologia 52(5): 437-446.

Observation : Valve shape is elliptical with narrower and more capitate to apices. Valve is 16-20 ㎛ long and 6.7-8 ㎛ wide. Raphe is straight. Central raphe ending is simple and expanded like small pore. Areolae is large and round. Striae is radial. The density of Striae is 12-15 in 10 ㎛.

Fogedia elliptica Park, Khim, Koh & Witkowski

Lit. : Park, J., Khim, J.S., Ryu, J., Koh, C.-H. & Witkowski, A. (2013). An emended description of the genus Fogedia (Bacillariophyceae) with reports of four speci

Observation : Valve shape is elliptical. Valve is 38.7 ㎛ long and 6 ㎛ wide. Central raphe ending is simple and expanded like small pore. External polar raphe endings is hooked. The density of Striae is 12 in 10 ㎛. In LM, areloea is pore and transverse areolae is 19-21 in 10 ㎛.

Fogedia lyra Park, Khim, Koh & Witkowski

Lit. : Park, J., Khim, J.S., Ryu, J., Koh, C.-H. & Witkowski, A. (2013). An emended description of the genus Fogedia (Bacillariophyceae) with reports of four species new to science from a Korean sand flat. Phycologia 52(5): 437-446.

Observation : Valve shape is elliptical with narrower and sharper towards

apices. Valve is 29.3-31.3 ㎛ long and 10-10.7 ㎛ wide. A curved hyaline appears between the valve and the raphe. Raphe is straight. Central raphe ending is simple and expanded like small pore. Areolae is linear. Striae is parallel in the central region and radial to both apices. The density of Striae is 12 in 10 ㎛.

Gyrosigma Hassall, 1845, nom. cons.

Holotype Species : *Gyrosigma hippocampus* Hassall

Gyrosigma sterrenburgii S.R.Stidolph

Lit. : Stidolph, S.R. (1992). Observations and remarks on the morphology and taxonomy of the diatom genera Gyrosigma Hassal and Pleurosigma W.Smith. III. Gyrosigma sterrenburgii sp. nov. and Pleurosigma amara sp. nov.. Diatom Research 7(2): 345-366.

Observation : Valve shape is linear and lanceolate. Valve is 113.3 ㎛ long and 14.7 ㎛ wide. Central area is elliptical and central raphe ending is simple, elliptical. And raphe shape is sigmoid. The transverse striae are fine, evenly spaced throughout and parallel.

Gyrosigma sp. 1

Observation : Valve shape is linear and lanceolate. Valve is 49.3-71.3 ㎛ long and 8-10.7 ㎛ wide. Central area is small and central raphe ending is simple, circular. Central raphe ending not clearly visible in LM. And raphe shape is sigmoid. The transverse striae are fine, evenly spaced throughout and parallel.

Gyrosigma sp. 2

Observation : Valve shape is linear and lanceolate. Valve is 66.7 ㎛ long and 10.7 ㎛ wide. Central area is small and central raphe ending is simple, circular. Central raphe ending not clearly visible in LM. And raphe shape is sigmoid. The transverse striae are fine, evenly spaced throughout and parallel.

Haslea Simonsen, 1974

Holotype Species : *Haslea ostrearia* (Gaillon) Simonsen

Haslea sp.

Observation : Valve shape is elongate, with narrower towards apices. Valve is 13.3 ㎛ long and 4.7 ㎛ wide. Raphe is straight. Central raphe ending is simple and expanded like small pore. Terminal raphe ending bent in the same direction. Areolae appear round or square when viewed under a microscope. Striae is nearly parallel. The density of Striae is 18 in 10 ㎛.

Hippodonta Lange-Bertalot, Witkowski & Metzeltin, 1996

Holotype Species : *Hippodonta luneburgensis* (Grunow) Lange-Bertalot, Metzeltin & A.Witkowski

Hippodonta linearis (Østrup) Lange-Bertalot, Metzeltin & Witkowski

Bas. : *Navicula hungarica* var. *linearis* Østrup

Lit. : Lange-Bertalot, H., Metzeltin, D. & Witkowski, A (1996). Hippodonta gen. nov. Umschreibung und Begründung einer neuer Gattung der Naviculaceae. Iconographia Diatomologica 4: 247-275.

Observation : Valve shape is elliptical and linear. Valve is 13.3 ㎛ long and 4.7 ㎛ wide. Areolae is not clearly observed under the microscope. Raphe is straight. Central raphe ending is simple and expanded like small pore. Terminal raphe ending is sticky and bent in the same direction. Apices slightly raised. Central raphe ending area extends horizontally. Striae is nearly parallel. The density of Striae is 18 in 10 ㎛. apices.

Distribution : This is a brackish species.

Hippodonta sp.

Observation : Valve shape is elliptical and linear. Valve is 13.3 ㎛ long and 4.7 ㎛ wide. Areolae is not clearly observed under the microscope. Raphe is straight. Central raphe ending is simple and expanded like small pore. Terminal raphe ending is sticky and bent in the same direction like hook. Central raphe ending area extends horizontally. Striae is nearly parallel. The density of Striae is 18 in 10 ㎛. apices.

Navicula Bory, 1822

Holotype Species : *Navicula tripunctata* (O.F.Müller) Bory

Navicula arenaria Donkin

Lit. : Donkin, A.S. (1861). On the marine Diatomaceae of Northumberland with a description of several new species. Quarterly Journal of Microscopical Science, New Series 1: 1-15, pl. I.

Observation : Valve shape is elliptical. Valve is 29.3-41.3 ㎛ long and 4.7-6.7 ㎛ wide. Central raphe ending is deflected in the same direction and expanded like pore. Sometimes the Central nodule extends in the deflected direction of the raphe ending. The density of Striae is 9-12 in 10 ㎛. In LM, areloea is linear and noticeable. Transverse areolae is 18-21 in 10 ㎛.

Navicula bipustulata Mann

Observation : The valve is rugged and irregular. Valve is 13.3 ㎛ long and 4.7 ㎛ wide. Areolae is radiate and curved striae formed by long prominent lineolae.

Navicula cancellata Donkin

Lit. : Donkin, A.S. (1873). The natural history of the British Diatomaceae. Part III. pp. 49-74, pls 9-12. London: John Van Voorst, 1 Paternoster Row.

Observation : Valve shape is linear and elliptical. Valve is 52-66.7 ㎛ long and 8-10 ㎛ wide. Central raphe ending is weakly deflected in the same direction. In LM, areolae is seem pore. Transverse areolae is 15-18 in 10 ㎛. Sometimes the central raphe ending area is a little extend. The density of Striae is 9 in 10 ㎛.

Distribution : *N. cancellata* is marine and brackish water species (Witkowski et al,. 2000). In Korea, this species has been reported in Saemangeum tidal flats (Park, 2012).

Navicula flanatica Grunow

Lit. : Grunow, A. (1860). Über neue oder ungenügend gekannte Algen. Erste Folge, Diatomeen, Familie Naviculaceen. Verhandlungen der Kaiserlich-König lichen Zoologisch-Botanischen Gesellschaft in Wein 10: 503-582, pls III-VII.

Observation : Valve shape is elongate. Valve is 20-31.3 ㎛ long and 4-6 ㎛ wide. Central raphe ending is simple and expanded like pore. The density of Striae is 9-12 in 10 ㎛. In LM, areloea is linear and noticeable. Transverse areolae is 24 in 10 ㎛.

Navicula gregaria Donkin

Lit. : Donkin, A.S. (1861). On the marine Diatomaceae of Northumberland with a description of several new species. Quarterly Journal of Microscopical Science, New Series 1: 1-15, pl. I.

Observation : Valve shape is elliptical and capitate. Valve is 34.7-35.3 ㎛ long and 8-8.7 ㎛ wide. Central raphe ending is deflected in the same direction and expanded like pore. Transverse areolae is 18 in 10 ㎛. Narrow hyaline space runs from the central raphe ending area. Sometimes the central raphe ending area is a little extend. External polar raphe endings is strongly hooked. Striae is parallel in the central region and radial to both apices. The density of Striae is 12 in 10 ㎛.

Distribution : Along the coasts, in brackish river estuaries and in inland salt springs. In eutrophic waters - (1 Jun 2010) - Salvador Valenzuela Miranda

Navicula spartinetensis Sullivan & Reimer

Lit. : Sullivan & Reimer 1975: 118, pl. 1: fig. 3, pl. 2: fig. 3

Observation : Valve shape is elliptical. Valve is 37.3 ㎛ long and 6 ㎛ wide. Central raphe ending is simple and expanded like pore. Transverse areolae is 21 in 10 ㎛. Wide hyaline space runs from the central raphe ending area.

Sometimes the central raphe ending area is a little extend. External polar raphe endings is hooked. Striae is almost parallel in the central region and both apices. The density of Striae is 12 in 10 ㎛.

Navicula cf. *perrhombus* Hustedt ex Simonsen

Observation : The valve is rugged and irregular. Valve is 13.3 ㎛ long and 4.7 ㎛ wide. Areolae is radiate and curved striae formed by long prominent lineolae.

Navicula sp. 1

Observation : Valve shape is short elliptical. Valve is 34 ㎛ long and 10 ㎛ wide. Central raphe ending is deflected in the same direction and expanded like pore. Striae in central region radial. The density of Striae is 12 in 10 ㎛.

Navicula sp. 2

Observation : Valve shape is elliptical. Valve is 16-17.3 ㎛ long and 4 ㎛ wide. Areolae and Striae inconspicuous. The density of Striae is 18-20 in 10 ㎛.

Navicula sp. 3

Observation : Valve shape is elliptical. Valve is 31.3-40.7 ㎛ long and 10-11.3 ㎛ wide. Central raphe ending is simple and expanded like small pore. External polar raphe endings is hooked. The density of Striae is 9-12 in 10 ㎛. In LM, areloea is linear and transverse areolae is 19-21 in 10 ㎛.

Navicula sp. 4

Observation : Valve shape is elliptical. Valve is 31.3-33.3 ㎛ long and 5.3-6 ㎛ wide. Central raphe ending is deflected in the same direction and central nodule extends in the deflected direction of the raphe ending. In LM, areloea

is linear. The density of Striae is 9-12 in 10 ㎛.

Navicula sp. 5

Observation : Valve shape is elliptical. Valve is 22 ㎛ long and 4.7 ㎛ wide. Central raphe ending is simple and expanded like small pore. External polar raphe endings is hooked. In LM, Areolae is inconspicuous. The density of Striae is 18 in 10 ㎛.

Navicula sp. 6

Observation : Valve shape is elliptical and sharp at both ends. Valve is 12-29.3 ㎛ long and 2-5.3 ㎛ wide. Central raphe ending is simple and expanded like small pore. The density of Striae is 12 in 10 ㎛.

Navicula sp. 7

Observation : Valve shape is elliptical. Valve is 43.3 ㎛ long and 5.3 ㎛ wide. Central raphe ending is deflected in the same direction and Central nodule extends in the deflected direction of the raphe ending. In LM, areloea is linear, Striae in central region radial. The density of areolae is 12 in 10 ㎛.

Navicula sp. 8

Observation : Valve shape is elliptical. Valve is 36.7-53.3 ㎛ long and 4-5.3 ㎛ wide. Central raphe ending is deflected in the same direction and central nodule extends in the deflected direction of the raphe ending. Central area extends horizontally. In LM, areloea is linear, The density of areolae is 12-15 in 10 ㎛.

Navicula sp. 9

Observation : Valve shape is elliptical. Valve is 42.7 ㎛ long and 7.3 ㎛ wide.

Central raphe ending is simple and expanded like small pore. In LM, areloea is linear, Striae in parallel. The density of areolae is 12 in 10 ㎛.

Navicula sp. 10

Observation : Valve shape is elliptical. Valve is 26-32 ㎛ long and 4.7-5.3 ㎛ wide. Central raphe ending is deflected in the same direction, slightly expanded hyaline space opposite the bent Central raphe ending. Sometimes the central raphe ending appears to be a continuation. The density of areolae is 12-15 in 10 ㎛.

Navicula sp. 11

Observation : Valve shape is elliptical. Valve is 18 ㎛ long and 3.3 ㎛ wide. Central raphe ending is simple. In LM, areolae and Striae inconspicuous.

Navicula sp. 12

Observation : Valve shape is oval, long and wide, heteropolar and heterovalve. Valve is 48.7-52.7 ㎛ long and 8-10 ㎛ wide. Central raphe ending is deflected in the same direction. Central area extends horizontally. Striae is parallel, the density of areolae is 12-15 in 10 ㎛.

Navicula sp. 13

Observation : Valve shape is elliptical and heterovalve. Valve is 30-44 ㎛ long and 5.3-6.7 ㎛ wide. Central raphe ending is deflected in the same direction and Sometimes the Central nodule extends in the deflected direction of the raphe ending. The density of areolae is 12-13.5 in 10 ㎛.

Navicula sp. 14

Observation : Valve shape is elliptical and sharp at both ends. Valve is 43.3-46.7 ㎛ long and 9.3-11.3 ㎛ wide. Central raphe ending is deflected in

the same direction, sternum in the central area is expanded. The formation of Striae in the central area is irregular. The density of areolae is 12-13.5 in 10 ㎛.

Navicula sp. 15

Observation : Valve shape is elliptical. Valve is 29.3 ㎛ long and 4.7 ㎛ wide. Central raphe ending is simple and expanded like small pore. Fascia appears transverse in the Central area. The density of areolae is 15 in 10 ㎛.

Navicula sp. 16

Observation : Valve shape is elliptical. Valve is 50 ㎛ long and 6.7 ㎛ wide. Central raphe ending is deflected in the same direction, Central nodule extends in the deflected direction of the raphe ending. External polar raphe endings is strongly hooked. The density of areolae is 15 in 10 ㎛.

Navicula sp. 17

Observation : Valve shape is elliptical. Valve is 52 ㎛ long and 7.3 ㎛ wide. Central raphe ending is deflected in the same direction, Central nodule extends in the deflected direction of the raphe ending. In LM, areloea is pore and noticeable. Transverse areolae is 21 in 10 ㎛. The density of areolae is 12 in 10 ㎛.

Navicula sp. 18

Observation : Valve shape is elliptical, sharp at both ends. Valve is 37.3 ㎛ long and 6 ㎛ wide. Central raphe ending is simple, Sternum thick raphe vertically. In LM, areloea is pore and transverse areolae is 21 in 10 ㎛. The density of areolae is 12-13.5 in 10 ㎛.

Parlibellus E.J. Cox, 1988

Holotype Species : *Parlibellus delognei* (Van Heurck) E.J.Cox

Parlibellus cf. *protracta*

Observation : Valve shape is lanceolate and capitate. Valve is 24 ㎛ long and 6 ㎛ wide. In LM, Areolae is inconspicuous. In the raphe ending area, the hyaline slightly extends. Striea is radial. The density of Striea is 21 in 10 ㎛. Central raphe ending is simple and expanded like small pore.

Parlibellus cf. *plicatus*

Observation : Valve shape is oval and lanceolate. Valve is 37.3-43.3 ㎛ long and 6.7-9.3 ㎛ wide. In LM, Areolae looks like a dot. In the raphe ending area, the hyaline slightly extends. Striea is radial. The density of Striea is 15-18 in 10 ㎛. Central raphe ending is simple.

Parlibellus sp. 1

Observation : Valve shape is lanceolate. Valve is 52 ㎛ long and 8 ㎛ wide. In LM, Areolae looks like a dot, but with tight spacing. Striea is parallel. The density of Striea is 15 in 10 ㎛. Striea is parallel in center but radial toward the axis. In the raphe ending area, the hyaline extends slightly in the horizontal direction.

Parlibellus sp. 2

Observation : Valve shape is lanceolate. Valve is 31.3-46.7 ㎛ long and 6-10 ㎛ wide. In LM, Areolae looks like a dot, but with tight spacing. Striea is radial. The density of Striea is 15-18 in 10 ㎛. In the raphe ending area, the hyaline extends slightly in the horizontal direction. The spacing between raphe endings is 1.3-2 ㎛.

Parlibellus sp. 3

Observation : Valve shape is lanceolate. Valve is 38 ㎛ long and 6.7 ㎛ wide. In LM, Areolae looks like a dot, but with tight spacing. Striea is parallel. The density of Striea is 21 in 10 ㎛. In the raphe ending area, the hyaline extends slightly in the horizontal direction. The spacing between raphe endings is 2 ㎛.

Parlibellus sp. 4

Observation : Valve shape is linear and lanceolate. Valve is 21.3-22.7 ㎛ long and 3.3-4.7 ㎛ wide. In LM, Areolae is inconspicuous. Striea is radial. The density of Striea is 18-21 in 10 ㎛. The spacing between raphe endings is 1.3 ㎛. Central raphe ending is simple and expanded like small pore.

Parlibellus sp. 5

Observation : Valve shape is oval and lanceolate. Valve is 14-20.7 ㎛ long and 5.3-6 ㎛ wide. In LM, Areolae is inconspicuous. Striea is almost parallel. The density of Striea is 18-21 in 10 ㎛. Central raphe ending is simple and expanded like small pore.

Seminavis D.G.Mann, 1990

Holotype Species : *Seminavis gracilenta* (Grunow ex A.Schmidt) D.G.Mann

Seminavis sp. 1

Observation : Valve shape is semi-lanceolate. Valve is 29.3 ㎛ long and 6.7 ㎛ wide. Raphe is located near the ventral margin. Also in LM areolae is inconspicuous. The density of striae is 15 at 10 ㎛.

Seminavis sp. 2

Observation : Valve shape is semi-lanceolate. Valve is 32.7 ㎛ long and 6 ㎛ wide. Raphe is located near the ventral margin. The raphe is straight. Also in LM areolae is inconspicuous. The density of striae is 12 at 10 ㎛.

Pinnularia Ehrenberg

Holotype Species : *Pinnularia viridis* (Nitzsch) Ehrenberg

Pinnularia trevelyana

Lit. : Rabenhorst, L. (1864). Flora europaea algarum aquae dulcis et submarinae. Sectio I. Algas diatomaceas complectens, cum figuris generum omnium xylographice impressis. pp. 1-359. Lipsiae [Leipzig]: Apud Eduardum Kummerum.

Observation : Valve shape is elongated. Valve is 56 ㎛ long and 12.7 ㎛ wide. The valve goes higher toward the apices. In LM, Areolae is inconspicuous. Central raphe ending is deflected in the same direction and expanded like pore. Striae is radial. The density of Striae is 9 in 10 ㎛.

Pinnularia sp. 1

Observation : Valve shape is elongated, with narrow near the apices. Valve is 27.3 ㎛ long and 4.7 ㎛ wide. Central area become wide, with shape rhombic. In LM, Areolae is inconspicuous. Central raphe ending is deflected in the same direction and expanded like pore. And external polar raphe endings strongly hooked. Striae is radial. The density of Striae is 15 in 10 ㎛.

Pinnularia sp. 2

Observation : Valve shape is oval, with narrow near the apices. Valve is 13.3 ㎛ long and 6 ㎛ wide. Central area become wide, with shape rhombic. In LM, Areolae is inconspicuous. Central raphe ending is simple and expanded like small pore. Striae is radial. Striae gets closer to raphe as it gets closer to apices. Striae is far from raphe in the central area. The density of Striae is 21 in 10 ㎛.

Pinnularia sp. 3

Observation : Valve shape is elongated. Valve is 22.7 ㎛ long and 6.7 ㎛ wide. Central area become wide, with shape rhombic. In LM, Areolae is inconspicuous. Central raphe ending is simple. Striae is radial. Striae appears short at the edges in the center area. The density of Striae is 15 in 10 ㎛.

Pinnularia sp. 4

Observation : Valve shape is elongated. Valve is 22.7 ㎛ long and 6.7 ㎛ wide. Central area become wide, with shape rhombic. In LM, Areolae is inconspicuous. Central raphe ending is simple. Striae is radial. Striae appears short at the edges in the center area. The density of Striae is 15 in 10 ㎛.

Plagiotropis Pfitzer, 1871

Holotype Species : *Plagiotropis baltica* Pfitzer

Plagiotropis cf. *tayrecta*

Lit. : Paddock, T.B.B. (1988). Plagiotropis Pfitzer and Tropidoneis Cleve, a summary account. Bibliotheca Diatomologica 16: 1-152, 38 pls.

Observation : In LM the valve shape is linear and lanceolate. Valve is 52.7-74.7 ㎛ long and 3.3-4.7 ㎛ wide. The density of Striae is 18 in 10 ㎛ and almost parallel. The Areolae looks like a dot in LM. The density of Areolae is 12 in 10 ㎛ (center) and 21 in 10 ㎛ (end). In LM, both vertices appear strongly thick.

Pleurosigm W.Smith, 1852, nom. et typ. cons.

Holotype Species : *Pleurosigma angulatum* (J.T.Quekett) W.Smith

Pleurosigma sp. 1

Observation : The valve shape is a narrow sigmoid. Valve is 90 ㎛ long and 16.7 ㎛ wide. Raphe is also in sigmoid form. Central raphe ending not noticeable in LM, but entral nodule is small circular. The raphe ending towards Apices bends strongly. Striae form is decussate.

Pleurosigma sp. 2

Observation : The valve shape is a wide sigmoid. Valve is 153.4 ㎛ long and 33.4 ㎛ wide. Raphe is also in sigmoid form. Central raphe ending not noticeable in LM, but central nodule is small circular. Striae form is decussate.

Pleurosigma sp. 3

Observation : The valve shape is a wide sigmoid. Valve is 73.4 ㎛ long and 33.4 ㎛ wide. Raphe is also in sigmoid form. Central raphe ending not noticeable in LM, but central nodule is small circular. The raphe ending towards Apices bends strongly. Striae form is decussate.

Donkinia Ralfs, 1861

Holotype Species : *Donkinia carinata* (Donkin) Ralfs

Donkinia recta (Donkin) Carruthers

Bas. : *Pleurosigma rectum* Donkin

Lit. : Carruthers, W. (1864). The Diatomaceae. In: Handbook of British water-weeds or algae. (Gray, J.E. Eds), pp. 75-116. London: R. Hardwicke, Picadilly.

Observation : The valve shape is elongated. Valve is 65.3 ㎛ long and 6.7 ㎛ wide. Areolae in LM is inconspicuous. Striae was also inconspicuous in LM observations. Raphe is a sigmoid that bends close to the valve mantle. Central raphe ending not noticeable in LM

Scolioneis D.G.Mann, 1990

Holotype Species : *Scolioneis tumida* (Brébisson ex Kützing) D.G.Mann

Scolioneis sp. 1

Observation : Valve shape is elongate. Valve is 26-32 ㎛ long and 6-8.7 ㎛ wide. Raphe is twisted diagonally. Central raphe ending is simple. Raphe-Sternum is narrow but slightly expanded in the central area. In the central area, Striae is slightly twisted in the opposite direction of the raphe. The density of Striae is 15-18 in 10 ㎛. In LM, areolae is inconspicuous.

Scolioneis sp. 2

Observation : Valve shape is oval and elongate. Valve is 35.3 ㎛ long and 8 ㎛ wide. Raphe is twisted diagonally. Central raphe ending is simple and expanded like small pore. Raphe-Sternum is narrow but broad expanded in the central area. In the central area, Striae is slightly twisted in the opposite direction of the raphe. The density of Striae is 15 in 10 ㎛. In LM, areolae is rarely observed, but often looks like a pore in the central region.

Diademoides K.-D.Kemp & T.B.B.Paddock, 1990

Holotype Species : *Diademoides luxuriosa* (Greville) K.-D.Kemp & T.B.B.Paddock

Diademoides luxuriosa (Greville) K.-D.Kemp & T.B.B.Paddock

Bas. : *Navicula luxuriosa* Greville

Lit. : Kemp, K.-D. and Paddock, T.B.B. (1990). A description of two new species of the diatom genus Mastogloia with further observations on *M. amoyensis* and *M. gieskesii*. Diatom Research 5(2): 311-323.

Observation : The Valve shape is oval and elongate. Valve is 46 ㎛ long and 21.3 ㎛ wide. Raphe is straight. Central raphe ending is simple and expanded like small pore. Raphe-Sternum in the central area is expanded. Terminal raphe ending bent in the same direction. Sternum thick raphe vertically. Areolae is rectangular or oval. Thick hyaline along the valve mantle. The density of Striae is 9 in 10 ㎛.

Biremis D.G.Mann & E.J.Cox, 1990

Holotype Species : *Biremis ambigua* (Cleve) D.G.Mann

Biremis aff. *Ambigua* (Cleve) D.G.Mann

Bas. : *Pinnularia ambigua* Cleve

Lit. : Round, F.E., Crawford, R.M. & Mann, D.G. (1990). The diatoms biology and morphology of the genera. pp. [i-ix], 1-747. Cambridge: Cambridge University Press.

Observation : The Valve shape is narrow linear. Valve is 21.3-34 ㎛ long and 5.3-6.7 ㎛ wide. Raphe is straight. Central raphe ending is simple and expanded like small pore. The hyaline close to the valve mantle(Striae is not continued across valve face). Pore like areolae appears in valve mantle. The density of pore is 9-12 in 10 ㎛.

Biremis lucens (Hustedt) K.Sabbe, A.Witkowski & W.Vyverman

Lit. : Sabbe, K., Witkowski, A. & Vyverman, W. (1995). Taxonomy, morphology and ecology of Biremis lucens comb. nov. (Bacillariophyta): a brackish-marine, benthic diatom species comprising different morphological types. Botanica Marina 38: 379-391, 55 figs, 1 table.

Observation : The valve shape is narrow linear. Valve is 14-17.3 ㎛ long and 3.3-4 ㎛ wide. Raphe is straight. Central raphe ending is simple with deflected in the opposite direction. And expanded like small pore. The hyaline close to the valve mantle(Striae is not continued across valve face). Pore like areolae appears in valve mantle. The density of pore is 12-15 in 10 ㎛.

Biremis sp.

Observation : The valve shape is narrow linear. Valve is 22-30 ㎛ long and 4.7-5.3 ㎛ wide. Raphe is straight. Central raphe ending is simple with deflected in the opposite direction. And expanded like small pore. The hyaline

close to the valve mantle(Striae is not continued across valve face). Pore like areolae appears in valve mantle. The density of pore is 12 in 10 ㎛.

Fallacia Stickle & D.G.Mann, 1990

Holotype Species : *Fallacia pygmaea* (Kützing) Stickle & D.G.Mann

Fallacia litoricola (Hustedt) D.G.Mann

Lit. : Round, F.E., Crawford, R.M. & Mann, D.G. (1990). The diatoms biology and morphology of the genera. pp. [i-ix], 1-747. Cambridge: Cambridge University Press.

Bas.: *Navicula litoricola* Hustedt

Observation : Valve shape is naviculoid and narrow linear. Valve is 18-20 ㎛ long and 5.3-6 ㎛ wide. The raphe is straight and the central raphe ending is clear. Sternum thick raphe vertically. The density of Striae is 18-21 in 10 ㎛.

Fallacia scaldensis K.Sabbe & K.Muylaert

Lit. : Sabbe, K., Vyverman, W. & Muylaert, K. (1999). New and little-known Fallacia species (Bacillariophyta) from brackish and marine intertidal sandy sediments in Northwest Europe and North America. Phycologia 38: 8-22, 81 figs, 1 table.

Observation : Valve shape is naviculoid and narrow linear. Valve is 18-20 ㎛ long and 5.3-6 ㎛ wide. The raphe is straight and the central raphe ending is clear. Sternum thick raphe vertically. The density of Striae is 18-21 in 10 ㎛.

Fallacia tenera (Hustedt) D.G.Mann

Lit. : Round, F.E., Crawford, R.M. & Mann, D.G. (1990). The diatoms biology and morphology of the genera. pp. [i-ix], 1-747. Cambridge: Cambridge University Press.

Observation : Valve shape is naviculoid with broadly rounded apices. Valve is 13.3-15 ㎛ long and 6 ㎛ wide. The raphe is straight. The density of Striea is 18 in 10 ㎛. Hyaline area small, distinct lyre-shape.

Fallacia cf. *forcipata* (Greville) Stickle & D.G.Mann

Lit. : Round, F.E., Crawford, R.M. & Mann, D.G. (1990). The diatoms biology and morphology of the genera. pp. [i-ix], 1-747. Cambridge: Cambridge University Press.

Observation : Valve shape is naviculoid. Valve is 16.7-18 ㎛ long and 6.7-7.3 ㎛ wide. The raphe is straight. The density of Striae is 18 in 10 ㎛. Hyaline area small, distinct lyre-shape.

Fallacia cf. *subforcipata* (Hustedt) D.G.Mann

Lit. : Round, F.E., Crawford, R.M. & Mann, D.G. (1990). The diatoms biology and morphology of the genera. pp. [i-ix], 1-747. Cambridge: Cambridge University Press.

Observation : Valve shape is naviculoid and narrow linear. Valve is 18-20 ㎛ long and 5.3-6 ㎛ wide. The raphe is straight and the central raphe ending is clear. Sternum thick raphe vertically. The density of Striae is 18-21 in 10 ㎛.

Fallacia sp. 1

Observation : Valve shape is naviculoid. Valve is 16.7 ㎛ long and 7.3 ㎛ wide. The raphe is straight, the hyaline area is thick along the Raphe, distinct lyre-shape. The density of Striea is 21 in 10 ㎛.

Fallacia sp. 2

Observation : Valve shape is naviculoid with broadly rounded apices. Valve is 11.3-12 ㎛ long and 5.3-6.7 ㎛ wide. The raphe is straight, the hyaline area is thick along the Raphe, distinct lyre-shape. The density of Striea is 21 in 10 ㎛.

Fallacia sp. 3

Observation : Valve shape is naviculoid and slightly narrow oval. Valve is 11.3

㎛ long and 5.3 ㎛ wide. The raphe is straight, central raphe ending is simple and expanded like small pore, The lyre-shape is distinct. The density of Striea is 21 in 10 ㎛.

Fallacia sp. 4

Observation : Valve shape is naviculoid and slightly narrow oval. Valve is 10.7 ㎛ long and 4.7 ㎛ wide. The raphe is straight and distinct lyre-shape. The density of Striea is 36 in 10 ㎛.

Fallacia sp. 5

Observation : Valve shape is naviculoid with broadly rounded apices. Valve is 10.7 ㎛ long and 6 ㎛ wide. The raphe is straight and indistinct lyre-shape. The density of Striea is 24 in 10 ㎛.

Fallacia sp. 6

Observation : Valve shape is naviculoid with slightly narrow oval. Valve is 22 ㎛ long and 8.7 ㎛ wide. The raphe is straight, central raphe ending is simple and expanded like small pore, The lyre-shape is distinct and central area of lyre-shape slightly extends horizontally. The density of Striea is 24 in 10 ㎛.

Fallacia sp. 7

Observation : Valve shape is naviculoid with slightly narrow oval. Valve is 26.7 ㎛ long and 12 ㎛ wide. The raphe is straight. The lyre-shape is distinct and overall lyre-shape is narrow, but lyre-shape area is large. The density of Striea is 21 in 10 ㎛.

Fallacia sp. 8

Observation : Valve shape is naviculoid with slightly narrow oval. Valve is 12.7 ㎛ long and 6.7 ㎛ wide. The raphe is straight. Overall lyre-shape is narrow. The density of Striea is 24 in 10 ㎛.

3.4 미기록종 및 신종

본 논문에서 관찰한 한국의 출현종 중에서 미기록종은 총 11속 17종으로 확인되었다. 미기록종에 대한 확인은 3차에 걸쳐 확인 하였다. 1차는 2015년에 국립생물자원관에서 발행한 국가 생물종 목록집의 '돌말류; Diatoms'를 참고하여 기록된 종과 미기록종을 분류하였다. 여기서 분류된 미기록종을 국립생물자원관에서 운영하는 '한반도의 생물다양성' 사이트에서 검색하여 미기록종을 2차로 분류하였다. 마지막으로 국내에서 발표된 미기록종 및 신종관련 9편의 논문을 참고하며 마지막으로 기록된 종과 미기록종을 분류하였다. 이렇게 분류한 미기록종은 Table 4와 같이 정리하였다.

Table 4. Species list of new record species by sites in the Korea

Species	BH 1	BH 2
Amphora richardiana	+	+
Cymbella affiniformis	+	+
Fragilaria gedanensis	+	+
Fragilaria sopotensis	+	+
Gyrosigma sterrenburgii	+	
Nitzschia solita		+
Opephora mutabilis		+
Opephora pacifica	+	+
Plagiotropis tayrecta	+	+
Planothidium delicatulum	+	+
Planothidium engelbrechtii	+	
Planothidium graum	+	
Planothidium pericavum	+	+
Staurophora salina		+
Thalassiosira hyperborea var. *lacunosa*	+	+
Tryblionella apiculata		+
Tryblionella hungarica		+

관찰된 규조류 속은 1개의 중심형 규조류를 제외하고, 모두 우상형 규조류에 속하는 속으로, 이들은 다시 Raphe의 유무에 따라서 Raphid 규조류와 Araphid 규조류로 분류하였다.

중심형 규조류에 속하는 속은 *Thalassiosira*가 있으며, 해당 속에서 출현한

종으로는 *Thalassiosira hyperborea* var. *lacunosa* 1종이 처음으로 한국에서 보고되었다.

Raphid 규조류에 속하는 속은 *Amphora*, *Cymbella*, *Fragilaria*, *Gyrosigma*, *Nitzschia*, *Plagiotropis*, *Planothidium*, *Staurophora*, *Tryblionella*의 9개 속으로, 해당 속의 14 종이 한국에서 처음으로 보고되었다. 처음으로 보고된 14 종은 *Amphora richardiana*, *Cymbella affiniformis*, *Fragilaria gedanensis*, *Fragilaria sopotensis*, *Gyrosigma sterrenburgii*, *Nitzschia solita*, *Plagiotropis tayrecta*, *Planothidium delicatulum*, *Planothidium engelbrechtii*, *Planothidium graum*, *Planothidium pericavum*, *Staurophora salina*, *Tryblionella apiculata*, *Tryblionella hungarica*로 관찰되었다.

Araphid 규조류에 속하는 속은 *Opephora*가 있으며, 해당 속에서 출현한 2 종은 *Opephora mutabilis*, *Opephora pacifica*로 한국에서 처음 보고되었다.

본 논문에서 신 종 또는 신 속으로 예상되는 1종이 관찰되었다. 해당 종에 대해서는 잠정적으로 *Dimeregramma* sp. 2로 동정하였고, *Dimeregramma* sp. 2의 기재는 다음과 같다.

Dimeregramma sp.

LM observation : Valve shape is lanceolate and narrow linear, with apices capitate. Valve is 19.3-48.7 ㎛ long and 5.3-6 ㎛ wide. Valve face is flat. Areolae is circular and large in size. Also, in the transverse direction, Areolae has a minimum density of 2-4 and a maximum of 6 density. Areolae appears in valve margins. A hyaline space with no areolae appears in the transverse direction in the central area. Striae is parallel, and the density of Striae is 9 in 10 ㎛.

SEM observation : Short spines appear in the rib at the valve edge. Areolae is circular in the central region but is oval in shape outside of the central region. Areolae form is cribra. Sternum is not clear apparent. Small pore fields appear in the margins of the apices, with short spines at the pore fields and valve interface. SEM observation did not find Rimoportula and Pseudoseptum. Hyaline space also appears in apices. Externally, the pore fields in apices are cribra, but internally small pore.

Dimeregramma sp. 을 광학 현미경과 주사전자현미경으로 관찰한 내용을 토대로 형태가 유사하다고 여겨지는 4개의 속을 선정하였다. 선정된 유사 속은 *Dimeregramma*, *Plagiogramma*, *Plasiogrammopsis*, *Glyphodesmis*로, 이들의 대표종인 *Dimeregramma minus* (W. Gregory) Ralfs, *Plagiogramma gregoryanum* Greville, *Plagiogrammopsis vanheurckii* (Grunow) Hasle, Stosch & Syvertsen, *Glyphodesmis eximia* Greville를 *Dimeregramma* sp.와 비교하였다. 비교를 위한 형태적 특징에는 Valve form과 Areola type, Sternum type, Central hyaline raised, Stria의 형태와 구조적인 특징인 Rimoportula, Pseudoseptum, Sternum, Fascia의 유무를 기준하였다. 그리고 이를 비교한 내용을 Table 5에 정리하였

다.

Table 5. Comparison of genera similar to our prospective new genus. (*Dimeregramma* sp.)

Genus name	*Dimeregramma*	*Plagiogramma*	*Plagiogrammopsis*	*Glyphodesmis*	Our species
Lectotype species	*Dimeregramma minus*	*Plagiogramma gregoryanum*	*Plagiogrammopsis vanheurckii*	*Glyphodesmis eximia*	
Valve form	linear, elliptical, subrostrate	elliptical, lanceolate	rostrate, lanceolate	lanceolate, elliptical	lanceolate, narrow linear, apices capitate
Areola type	cribra (round)	cribra	cribra (large, circular)	cribra	cribra
Stria	uniseriate (radiate)	uniseriate, (transverse)		uniseriate	uniseriate (parallel)
Rimoportula	Absent	Present	Present	Absent	Absent
Pseudoseptum	Absent	Present	Present	Absent	Absent
Sternum	Present	Present	Absent	Present	Absent
Sternum type	narrow, expanded in the center	narrow	-	narrow	-
Fascia	Absent	Present	Present	Present	Absent
Central hyaline raised	Absent	Absent	Absent	Present	Absent

Dimeregramma sp.와 valve 형태가 가장 유사한 속은 *Dimeregramma*와 *Plagiogramma*였다. 그 중에서도 valve 형태가 가장 유사한 속은 *Plagiogramma*인데, *Dimeregramma* sp.가 같은 길이 대비 *Plagiogramma*보다 세포의 너비가 더 좁은 형태를 보였다. Areola의 크기를 비교하면 *Plagiogramma*보다 *Dimeregramma* sp.의 크기가 더 크다. 그 다음으로 valve 형태가 유사한 속은 *Dimeregramma*인데, *Dimeregramma*와 *Dimeregramma* sp.의 차이는 apices의 형태이다. *Dimeregramma* sp.의 apices가 capitate한 형태를 가지나, *Dimeregramma*의 apices는 그렇지 않았다. 이러한 형태적 차이를 바탕으로 *Dimeregramma* sp.은 *Dimeregramma*와 *Plagiogramma*와 다른 속으로 여겨진다 (Table 5).

Valve 형태 외에도 구조적인 특징으로 속을 구분하는데, 본 논문에서는 Stria, Rimoportula, Pseudoseptum, Sternum, Sternum type, Fascia를 이용해

Dimeregramma sp.와 유사 속 4개를 비교하였다(Table 5). 그리고 구조적인 부분을 비교하였을 때, *Dimeregramma* sp.와 가장 유사한 속은 *Dimeregramma*였다. *Dimeregramma*와 *Dimeregramma* sp.의 차이는 Striae의 형태와 Sternum의 유무였다. *Dimeregramma*는 Striae의 형태가 방사형(radiate)인 반면에 *Dimeregramma* sp.는 평행한(parallel) 형태로 차이를 보였다. 또한 Sternum의 경우, *Dimeregramma*가 좁게(narrow) 나타나면서, 중앙영역에서 뚜렷하게 Sternum이 확장된다(expanded). 하지만, *Dimeregramma* sp.의 경우 Sternum이 나타나지 않았다. Valve 형태가 가장 유사했던 *Plagiogramma*는 구조적인 특징이 *Dimeregramma* sp.와는 반대되는 결과를 보였다. *Dimeregramma* 다음으로 구조적인 특징이 유사한 속은 *Glyphodesmis*가이다. *Glyphodesmis*는 Sternum과 Fascia가 있는 반면에, *Dimeregramma* sp.는 Sternum과 Fascia가 없는 특징을 가졌다. 이런 이유로 *Glyphodesmis*와 *Dimeregramma* sp.는 다른 속으로 여겨진다.

Dimeregramma sp.는 유사 속 4개와 비교하였을 때, 이들과는 다른 특징을 가지고 있음을 확인하였다. 그러나 *Dimeregramma* sp.와 유사한 속과의 비교(Table 5)는 Valve에서 나타는 형태적 특징만을 고려했기 때문에 추후에, Girdle의 형태적인 특징과도 비교하는 후속 연구가 필요하다.

정리하자면, 본 논문에서 관찰된 *Dimeregramma* sp.는 *Dimeregramma* 속과 *Plagiogramma* 속은 아니지만, Plagiogrammaceae과에 속하는 새로운 속으로 예상된다.

3.5 한국과 중국의 규조류 군집의 다양성

한국(BH 1, BH 2)과 중국(RZ 1, RZ 2)의 각 정점에서 우점하는 상위 5개의 종과 상대적인 수도를 Table 6과 같이 정리하였다.

Table 6. Dominant species in sand flat of Korea and China, in each of sampling location.

BH 1		BH 2		RZ 1		RZ 2	
Species	%	Species	%	Species	%	Species	%
Navicula arenaria	15.3	*Navicula flanatica*	7.0	*Navicula* sp. 17	17.7	*Navicula* sp. 10	9.3
Amphora holsatica	9.3	*Amphora holsatica*	6.7	*Nitzschia hungarica*	8.7	*Navicula* sp. 12	6.3
Navicula sp. 3	7.0	*Fragilaria sopotensis*	6.3	*Diploneis nitescens*	8.0	*Navicula* sp. 13	5.0
Amphora richardiana	5.7	*Navicula arenaria*	5.7	*Nitzschia* sp. 1	5.7	*Biremis* aff. *ambigua*	4.7
Fragilaria sopotensis	3.7	*Amphora richardiana*	5.3	*Navicula* sp. 13	3.3	*Navicula* sp. 7	4.7

한국 낙동강 하구의 모래 갯벌에서 우점하는 속은 *Navicula*, *Amphora*, *Fragilaria*로 3개의 속이 우점하는 것으로 나타났다. 반면에, 중국 하구의 모래 갯벌에서는 *Navicula*, *Nitzschia*, *Diploneis*, *Biremis*로 4개의 속이 우점 속으로 관찰되었고, 한국 정점보다 속의 개수가 더 많은 것으로 타나났다(Table 6).

한국의 모래갯벌 정점에서 우점 종은 *Navicula arenaria*(21 %), *Navicula flanatica*(7 %), *Navicula* sp. 3(7 %), *Amphora holsatica*(16 %), *Amphora richardiana*(11 %) *Fragilaria sopotensis*,(10 %) 6종이다. 여기서 *Navicula* 속 3종의 상대적인 수도는 35 %를 차지할 만큼 높은 비율을 가진다. 낙동강 하구 지역의 이전 연구에서 *Navicula*를 포함한 Naviculoid 규조류는 해당 지역에서 풍부하게 나타나며, 종 구성에서도 높은 비율을 나타낸다(Joh, 2013). 우점 종을 통해서 한국 낙동강 하구의 모래갯벌에서 저서 규조류는 적은 수의 종이 군집에서 높은 비율을 차지하고 있음을 확인할 수 있었다.

중국 모래갯벌 정점에서 우점 종은 *Navicula* sp. 1(5.7 %), *Navicula* sp. 7(4.7 %), *Navicula* sp. 10(9.3 %), *Navicula* sp. 12(6.3 %), *Navicula* sp. 13(5 %), *Navicula* sp. 17(17.7 %), *Nitzschia hungarica*(8.7 %), *Nitzschia* sp. 1(5.7 %), *Diploneis nitescens*(8 %), *Biremis* aff. *ambigua*(4.7 %) 10종이다. 한국 정점과 같

이 중국 정점에서도 *Navicula* 속이 우점 속으로 나타났으며, 해당 속의 우점 종으로 6종이 관찰되었다. 이들의 상대적인 수도는 48.7 %로 높게 나타났다. 우점종 구성에서도 중국 정점이 한국 정점보다 다양한 종 구성을 보였다(Table 6). 상대적으로 중국 정점이 한국 정점보다 많은 수의 종이 군집을 이루고 있는 것이 관찰되었다.

한국과 중국 하구의 모래 갯벌에서 공통적으로 우점하는 규조류 속은 *Navicula*인 것으로 확인 되었다(Table 6). *Navicula* 속은 한국과 중국 조사지역에서 총 21 종이 발견되었다. 한국 정점에서는 *Naviclua arenaria* (21%)가, 중국에서는 *Navicula* sp. 19 (22.4%)가 *Navicula* 속 중, 각 연구지역에서 가장 우점하는 종임을 확인 할 수 있었다.

연구지역에서의 종 리스트를 이용해, 다양성 지수를 계산하였다. 계산된 다양성 지수는 PRIMER 6 프로그램 사용해 계산하였다. 다양성 지수에 많이 사용하는 Shannon-Weaver index와 Evenness, Richness를 각 정정별로 계산하여 Table 7 과 같이 정리하였다.

Table 7. Comparison of Diversity Indices According to Research Area and Characteristics of Sediment.

Country	Site	Number of occurred species	Diversity index		
			Shannon-Weaver index	Evenness	Richness
Korea	BH 1	74	3.63	12.81	0.84
	BH 2	71	3.74	12.27	0.88
China	RZ 1	86	3.64	14.90	0.82
	RZ 2	99	4.05	17.18	0.88

한국 정점의 경우, Shannon-Weaver index의 범위는 3.63-3.74, Evenness는 0.84-0.88, Richness는 12.27-12.81의 범위를 나타내었다. 중국 정점에서는 Shannon-Weaver index 값이 3.64-4.05, Evenness는 0.84-0.88, Richness는 12.27-12.81의 범위를 나타내었다.

이는 퇴적물 성상이 모래 갯벌인 지역에서 연구한 Li et al., (2017)의

Shannon-Weaver index 값 2.4와 Evenness값 0.70을 비교하였을 때 본 논문의 연구 지역의 다양성 지수가 더 높은 것을 볼 수 있었다. 또한 본 논문에서 계산된 Shannon-Weaver index 값은 퇴적물 성상이 뻘 갯벌인 지역에서 연구한 Woelfel et al., (2007) 논문의 Shannon-Weaver index 값인 3.5-4.7과 비교하였을 때, 비슷한 수준의 다양성을 갖는 것을 확인 할 수 있었다.

위와 같이 다양성 지수를 비교한 논문들은 규조류 군집의 계절적 변화를 보기 위해, 시료 채취가 최소 4번 이상 진행되었다. 반면에, 본 논문에서는 비슷한 위도를 갖는 지역 간의 규조류 군집을 살펴보았기 때문에 시료 채취는 1번만 진행되었다.

본 논문의 연구지역에서의 규조류 다양성 지수는 일반적인 모래갯벌의 다양성 지수보다 높게 나왔다. 이러한 이유에는 퇴적물의 성상이 큰 부분을 차지한다. 특히 중국 정점은 니질 함량 결과를 보았을 때, 모래와 뻘이 혼합된 퇴적환경이다. 퇴적물의 형태가 혼합 퇴적물일 경우, 규조류는 모래에서 서식하는 규조류와 뻘에서 서식하는 규조류가 모두 관찰될 수 있다. 실제로 뻘에서 주로 발견되는 규조류 속인 *Gyrosigma*와 *Pleurosigma*가 한국 정점과 중국 정점에서 관찰되었다.

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APPENDIX I 출현 규조류 도판

도판에 사용된 사진은 형광현미경으로 규조류의 Frustule를 촬영하였다. 이때 사용한 현미경 렌즈는 대물렌즈 100배, 접안렌즈 10배 총 1000배를 기본으로 하였다. 관찰에 사용한 렌즈는 OLYPUS 100배 렌즈, 카메라는 OLYPUS Tech X Cam Ⅲ과 ZEISS-Axiocam 305 color 카메라를 사용하였다.

Plate. 1

Figs 1a-1b : *Amphora arenicola*
Fig. 2 : *Amphora helenesis*
Fig. 3 : *Amphora maletractata* var. *constricta*
Figs 4a-4b : *Amphora costata*
Fig. 5 : *Amphora* cf. *terroris*
Fig. 6 : *Amphora* sp. 1
Fig. 7 : *Amphora* sp. 5
Fig. 8 : *Amphora holsatica*
Fig. 9 : *Amphora richardiana*
Fig. 10 : *Amphora* sp. 2
Fig. 11 : *Amphora* sp. 4
Fig. 12 : *Amphora* sp. 3
Fig. 13 : *Amphora* sp. 12
Fig. 14 : *Amphora* sp. 6
Fig. 15 : *Amphora* sp. 7
Fig. 16 : *Amphora* sp. 9
Fig. 17 : *Amphora* sp. 10
Fig. 18 : *Amphora* sp. 13

Plate. 2

Figs 1a-1b : *Aulacoseira granuulata*
Figs 2a-2b : *Aulacoseira* ambigua
Figs 3a-3b : *Cyclostephanos dubius*
Fig. 4 : *Thalassiosira hyperborea* var. *lacunosa*
Fig. 5 : *Cyclotella striata*
Fig. 6 : *Thalassiosira* sp. 1
Fig. 7 : *Stephanodiscus* sp.
Fig. 8 : *Discostella stelligera*
Fig. 9 : *Discostella* sp.
Fig. 10 : *Cyclostephanos* sp.
Fig. 11 : *Stephanodiscus hantzschii*
Fig. 12 : *Stephanopyxis* sp.
Fig. 13 : *Palaria sulcata*
Fig. 14 : *Cyclotella meneghiniana*

Plate. 3

Fig. 1 : *Achnanthes secretitaeniata*
Fig. 2 : *Dimeregramma minor*
Fig. 3 : *Achnanthes* cf. brevipes
Figs 4a-4b : *Plagiogramma* sp.
Fig. 5 : *Fragilaria sopotensis*
Fig. 6 : *Plagiogrammopsis* cf. *minima*
Fig. 7 : *Fragilaria vaucheriae*
Fig. 8 : *Grammatophora* cf. *marina*
Fig. 9 : *Odontidium* cf. *tabellaria*
Fig. 10 : *Odontidium* cf. *harrisonii*
Fig. 11 : *Opephora* cf. *mutabilis*
Fig. 12 : *Rhaphoneis* sp.
Fig. 13 : *Opephora* cf. *martyi*
Fig. 14 : *Trachysphenia* cf. *australis*
Fig. 15 : *Neofragilaria* cf. *nicobarica*
Fig. 16 : *Rhaphoneis* cf. *amphiceros*
Fig. 17 : *Staurosirella* cf. *pinnata*
Fig. 18 : *Neodelphineis plagica*
Fig. 19 : *Staurosira construens* var. *binodis*
Fig. 20 : *Tabularia* cf. *fasciculata*

Plate. 4

Fig. 1 : *Nitzschia amphibia*
Fig. 2 : *Nitzschia alpina*
Fig. 3 : *Nitzschia desertorum*
Fig. 4 : *Nitzschia granulata*
Fig. 5 : *Nitzschia* cf. *miserabili*
Fig. 6 : *Nitzschia* sp. 3
Fig. 7 : *Nitzschia lorenziana*
Fig. 8 : *Nitzschia adducta*
Fig. 9 : *Nitzschia* sp. 1
Fig. 10 : *Nitzschia hungarica*
Fig. 11 : *Nitzschia panduriformis*
Fig. 12 : *Nitzschia* sp. 2

Fig. 13 : *Fogedia densa*

Fig. 14 : *Biremis* aff. *ambigua*

Fig. 15 : *Achnanthes* sp. 2

Fig. 16 : *Cocconeiopsis* cf. *patrickae*

Fig. 17 : *Moreneis hexagona*

Plate. 5

Fig. 1 : *Grosigma* sp. 1

Fig. 2 : *Grosigma* sp. 2

Fig. 3 : *Grosigma sterrenburgii*

Figs 4a-4b : *Cocconeis placentula*

Plate. 6

Fig. 1 : *Plagiotropis* cf. *tayrecta*

Fis. 2a-2b : *Entomoneis alata*

Fig. 3 : *Bekeleya* cf. *rutilans*

Figs 4a-4b : *Entomoneis* sp.

Figs 5a-5b : *Cocconeis irregularis*

Figs 6a-6b : *Cocconeis distans*

Figs 7a-7b : *Cocconeis* cf. *sigillata*

Fig. 8 : *Donkinia recta*

Plate. 7

Fig. 1 : *Caloneis* cf. *westii*

Figs 2a-2b : *Caloneis* cf. *crassa*

Figs 3a-3b : *Cocconeis scutellum*

Fig. 4 : *Cocconeis* sp. 1

Fig. 5 : *Cocconeis* sp. 2

Fig. 6 : *Cocconeiopsis* sp.

Fig. 7 : *Cocconeis* sp. 3

Figs 8a-8b : *Fogedia densa*

Figs 9a-9b : *Fogedia lyra*

Plate. 8

Figs 1a-1b : *Anorthoneis* sp. 1

Fig. 2 : *Anorthoneis* sp. 2

Fig. 3 : *Petroneis* cf. *marina*

Figs 4a-4c : *Hippodonta linearis*

Figs 5a-5b : *Lyrella* cf. *spectabilis*

Fig. 6 : *Diademoides* aff. *luxuriosa*

Fig. 7 : *Petroneis* sp.

Figs 8a-8b : *Lyrella* cf. *hennedyi*

Plate. 9

Fig. 1 : *Hippodonta* sp.

Fig. 2 : *Catenula* sp.

Figs 3a-3b : *Gomphonema* cf. *micropus*

Fig. 4 : *Gomphonema* sp. 1

Fig. 5 : *Gomphonema* sp. 2

Figs 6a-6b : *Achnanthes* sp. 2

Figs 7a-7b : *Sturophora* cf. *salina*

Figs 8a-8b : *Scolioneis* sp. 1

Fig. 9 : *Scolioneis* sp. 2

Fig. 10 : *Sturophora* sp. 2

Fig. 11 : *Sturophora* sp. 3

Plate. 10

Fig. 1 : *Pleurosigma* sp. 1

Fig. 2 : *Pleurosigma* sp. 2

Fig. 3 : *Tryblionella apiculata*

Fig. 4 : *Tryblionella hungarica*

Fig. 5 : *Biremis lucens*

Fig. 6 : *Biremis* sp.

Fig. 7 : *Biremis lucens*

Fig. 8 : *Biremis* sp.

Fig. 9 : *Pleurosigma* sp. 3

Plate. 11

Fig. 1 : *Cymbella affinis*
Figs 2a-2b : *Planothidium graum*
Figs 3a-3c : *Planothidium engelbreechtii*
Fig. 4 : *Planothidium lilljeborgei*
Fig. 5 : *Planothidium* sp. 4
Figs 6a-6b : *Planothidium* sp. 1
Fig. 7 : *Sturophora* sp. 1
Figs 8a-8c : *Planothidium* cf. *engelbreechtii*
Figs 9a-9b : *Hippodonta* sp. 1
Fig. 10 : *Planothidium* sp. 2
Fig. 11 : *Planothidium* sp. 3

Plate. 12

Fig. 1 : *Fallacia litoricola*
Figs 2a-2b : *Fallacia* cf. *forcipata*
Fig. 3 : *Fallacia* sp. 1
Fig. 4 : *Fallacia tenera*
Figs 5a-5b : *Fallacia* cf. *subforcipata*
Figs 6a-6b : *Fallacia* sp. 2
Figs 7 : *Fallacia* sp. 5
Fig. 8 : *Pinnularia trevelyana*
Fig. 9 : *Fallacia* sp. 7
Fig. 10 : *Fallacia* sp. 6
Figs 11a-11b : *Lunella* sp.
Fig. 12 : *Fallacia* sp. 8
Fig. 13 : *Fallacia* sp. 3
Fig. 14 : *Fallacia* sp. 4
Fig. 15 : *Seminavis* sp. 1
Fig. 16 : *Seminavis* sp. 2

Plate. 13

Fig. 1 : *Parlibellus* sp. 1
Figs 2a-2d : *Parlibellus* sp. 2
Fig. 3 : *Parlibellus* cf. *plicatus*
Fig. 4 : *Parlibellus* sp. 2
Figs 5a-5b : *Parlibellus* sp. 5
Figs 6a-6b : *Parlibellus* sp. 4

Plate. 14

Fig. 1 : *Parlibellus* cf. protracta
Figs 2a-2b : *Pinnularia* sp. 1
Fig. 3 : *Pinnularia* sp. 3
Fig. 4 : *Pinnularia* sp. 4
Fig. 5 : *Pinnularia* sp. 5
Figs 6a-6b : *Diploneis* aff. *nitescens*
Fig. 7 : *Caloneis* sp.
Fig. 8 : *Diploneis* sp. 1
Fig. 9 : *Diploneis* aff. *nitescens*
Fig. 10 : *Diploneis aestuarii*
Fig. 11 : *Diploneis* cf. *notabilis*
Fig. 12 : *Diploneis* sp. 2
Fig. 13 : *Diploneis* cf. *stroemii*

Plate. 15

Figs 1a-1c : *Dimeregramma* sp.
Figs 2a-2b : UI 1
Fig. 3 : *Navicula* sp. 19
Fig. 4 : *Diploneis* sp. 3
Fig. 5 : *Luticola* sp.
Fig. 6 : *Chamaepinnularia* sp.
Fig. 7 : *Haslea* sp.
Fig. 8 : *Navicula* sp. 12
Fig. 9 : *Navicula* sp. 18
Fig. 10 : *Navicula* sp. 16

Plate. 16

Fig. 1 : *Navicula cancellata*
Fig. 2 : *Navicula* cf. *gregaria*
Figs 3a-3b : *Navicula* cf. *flanatica*
Fig. 4 : *Navicula* cf. *bipustulata*

Fig. 5 : *Navicula* sp. 2
Figs 6a-6b : *Navicula* cf. *arenaria*
Fig. 7 : *Navicula* sp. 1
Figs 8a-8b : *Navicula* sp. 3
Fig. 9 : *Geissleria decussis*

Plate. 17

Fig. 1 : *Navicula* sp. 4
Figs 2a-2b : *Navicula* sp. 6
Fis. 3a-3b : *Navicula* sp. 10
Fig. 4 : *Navicula* sp. 15
Fig. 5 : *Navicula* sp. 7
Fig. 6 : *Navicula* sp. 9
Figs 7a-7b : *Navicula spartinetensis*
Figs 8a-8b : *Navicula* sp. 13
Fig. 9 : *Navicula* sp. 14
Fig. 10 : *Navicula* sp. 8
Fig. 11 : *Navicula* sp. 10
Fig. 12 : *Navicula* sp. 5

Plate. 18

Fig. 1 : *Navicula* sp. 10
Fis. 2a-2c : *Plagiogramma* sp.
Fig. 3 : *Surirella* cf. *oestrupii*
Figs 4a-4b : *Thalassiosira* sp. 1
Fig. 5 : *Tryblionella apiculata*

Plate. 19

Figs 1a-1b : *Opephora* cf. mutabilis
Fig. 2 : *Amphora* sp. 13
Fig. 3 : *Nitzschia hungarica*
Fig. 4 : *Fogedia lyra*
Fig. 5 : *Gyrosigma* sp 1.
Fig. 6 : *Nitzschia adducta*
Fig. 7 : *Cyclotella. striata*

Plate. 20

Fig. 1 : *Planothidium* cf. *engelbrechtii*
Figs 2a-2b : *Planothidium* cf. *engelbrechtii*
Fig. 3 : *Cyclotella. meneghiniana*
Fig. 4 : *Nitzschia panduriformis*
Fig. 5 : *Fragilaria sopotensis*
Fig. 6 : *Palaria sulcata*
Fig. 7 : *Petroneis* cf. *marina*

Plate. 21

Fig. 1 : *Scolioneis* sp. 1
Fig. 2 : *Entomoneis alata*
Figs 3a-3b : *Sturophora* cf. *salina*
Fig. 4 : *Diploneis* aff. *nitescens*
Fig. 5 : *Fallacia tenera*
Fig. 6 : *Trachysphenia* cf. *australis*
Fig. 7 : *Neodelphineis plagica*

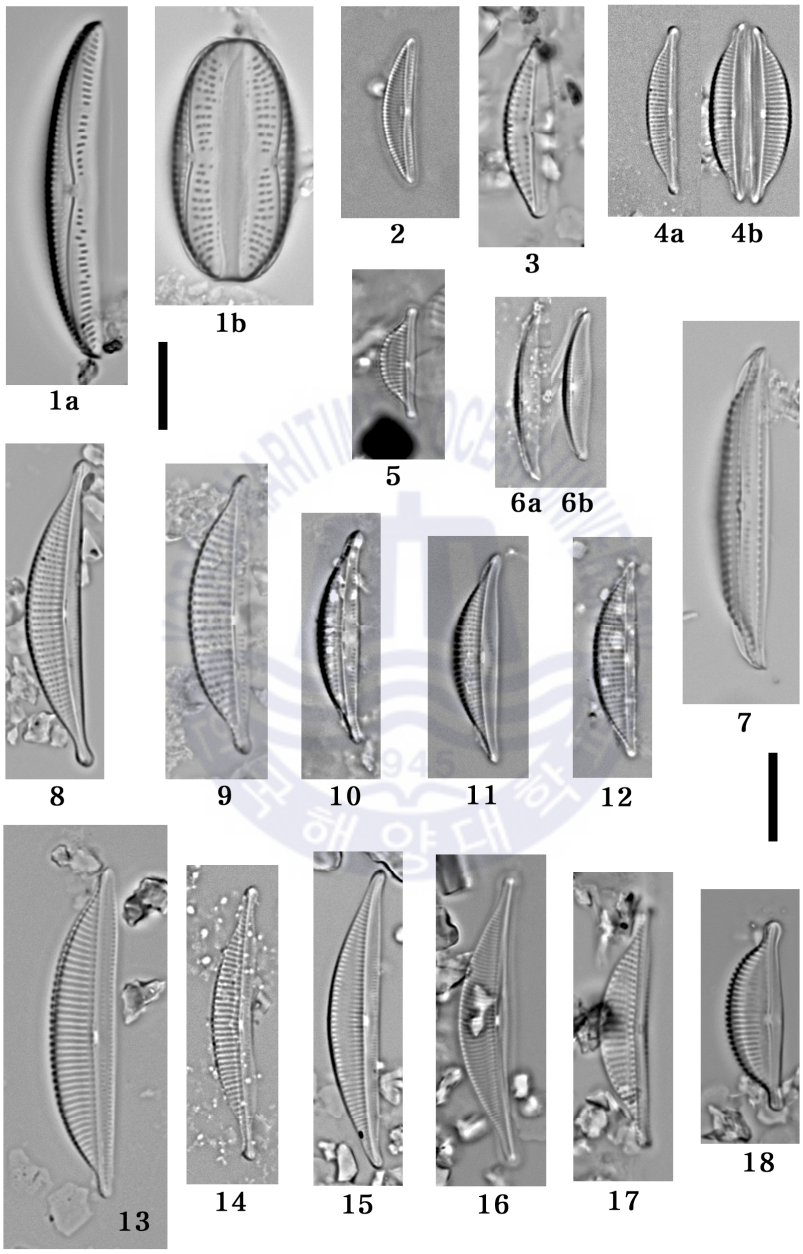
Plate. 22

Fig. 1 : *Biremis* aff. *ambigua*
Fig. 2 : *Chamaepinnularia* sp.
Fig. 3 : *Moreneis hexagona*
Fig. 4 : *Pinnularia trevelyana*
Fig. 5 : *Pleurosigma* sp. 1
Fig. 6 : UI 1
Fig. 7 : *Lyrella* sp. *spectabilis*
Fig. 8 : *Biremis* aff. *ambigua*

Plate. 23

Figs 1a-1c : *Dimeregramma* sp.
Figs 2a-2c : *Nitzschia* cf. *alpina*
Fig. 3 : *Parilbellus* sp. 2
Fig. 4 : *Amphora* sp. 6

Plate 1



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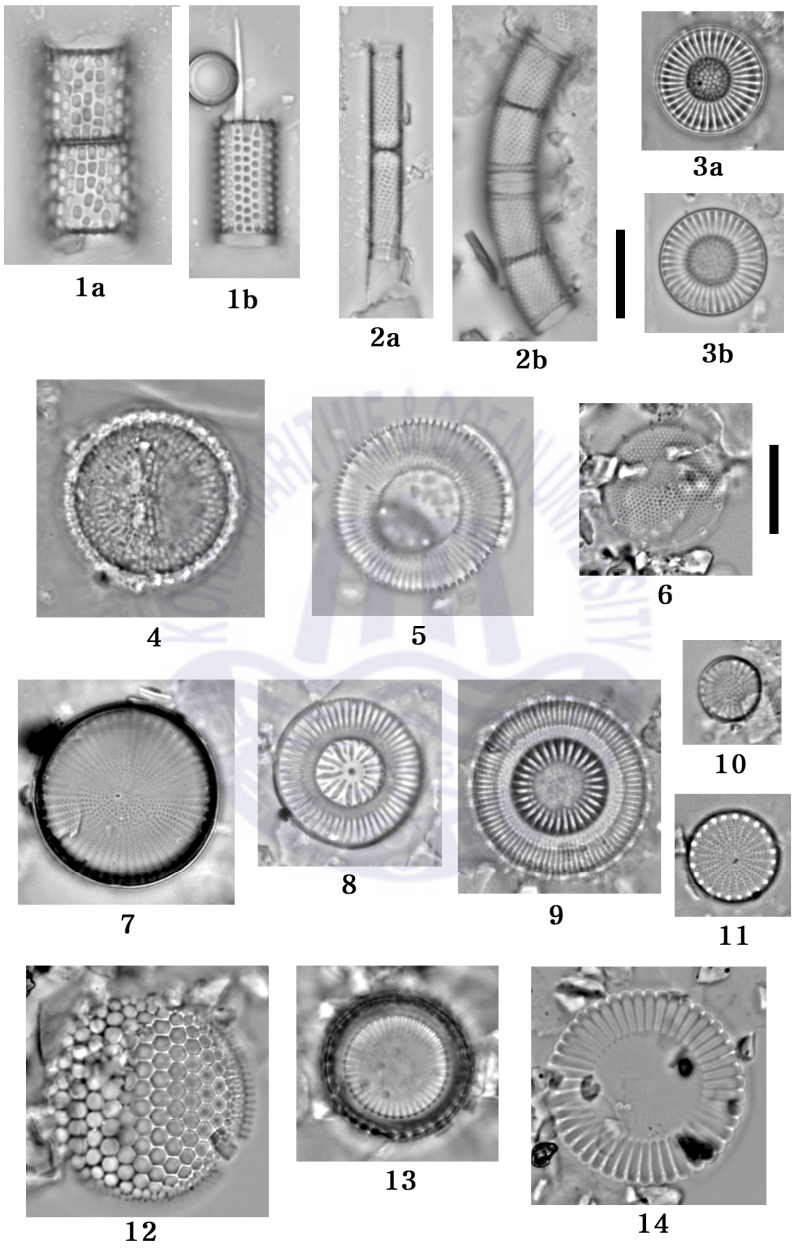

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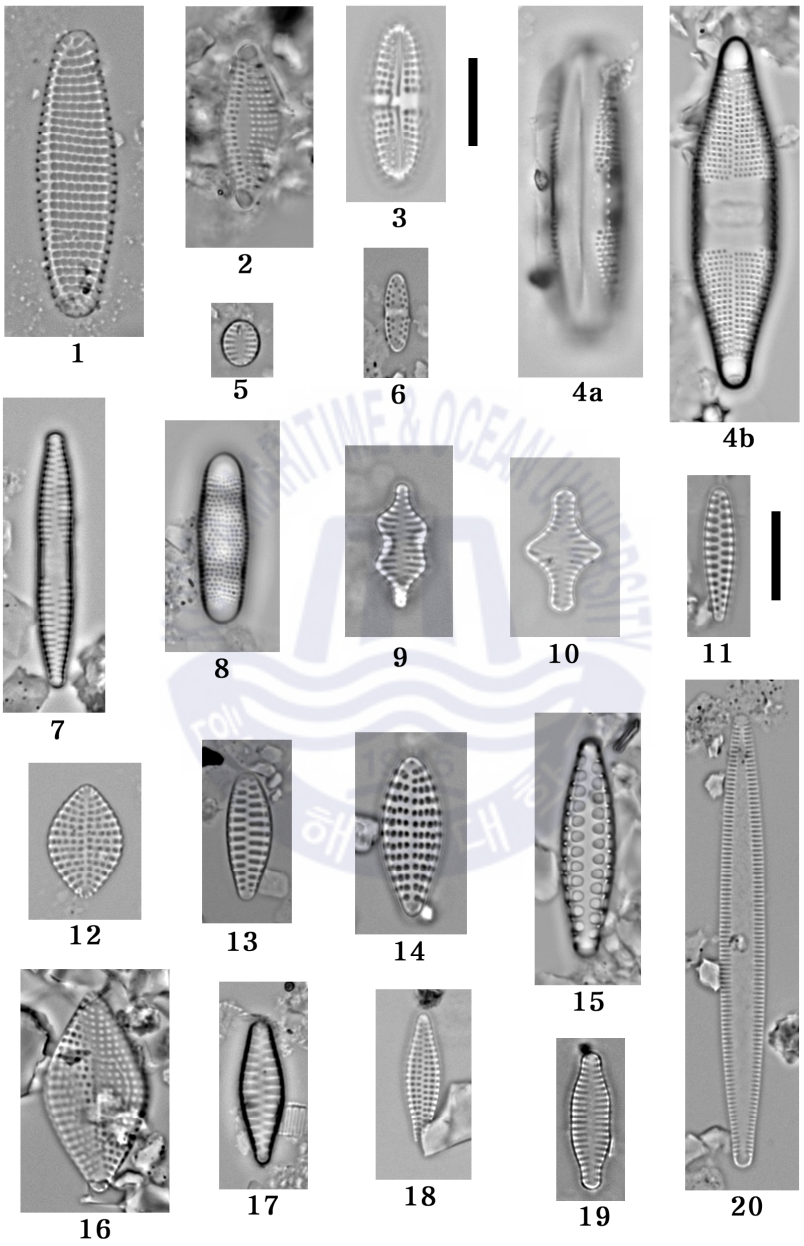

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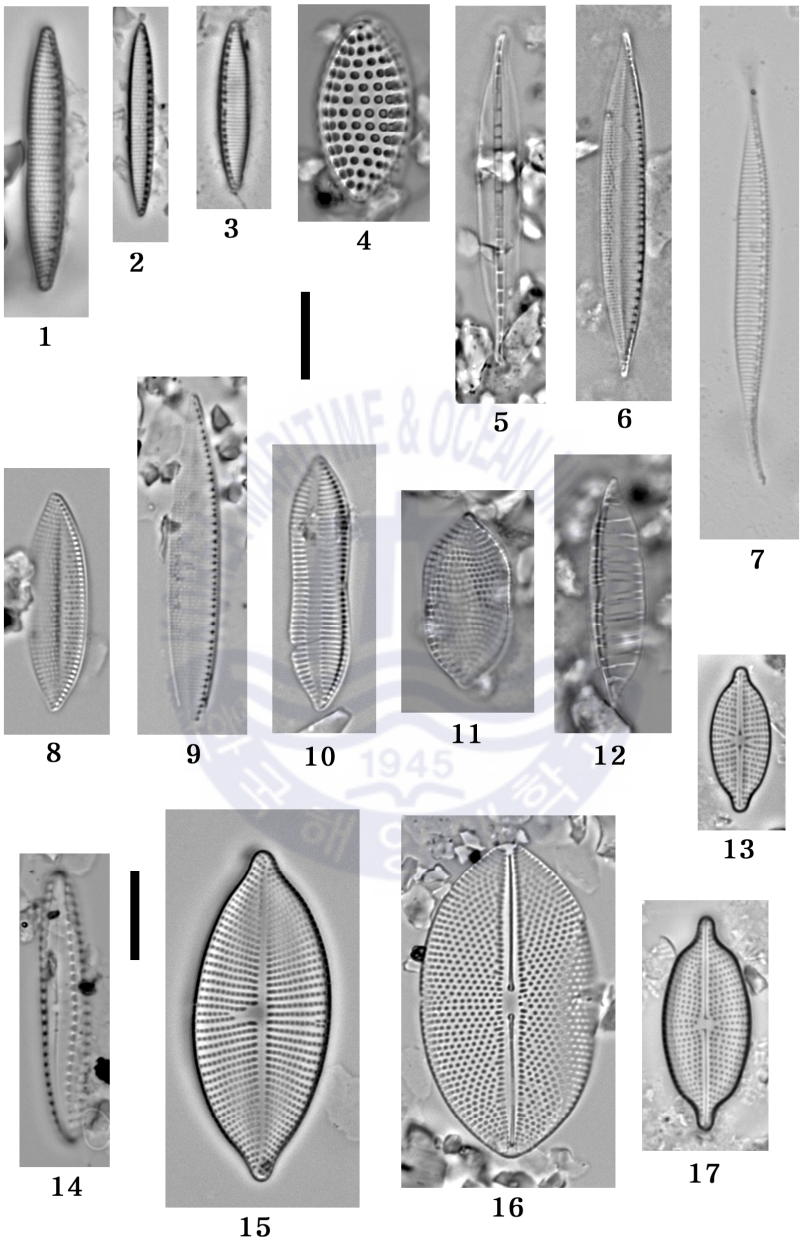

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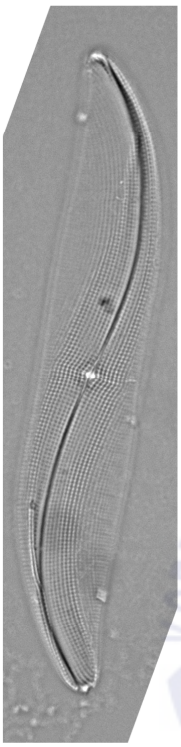

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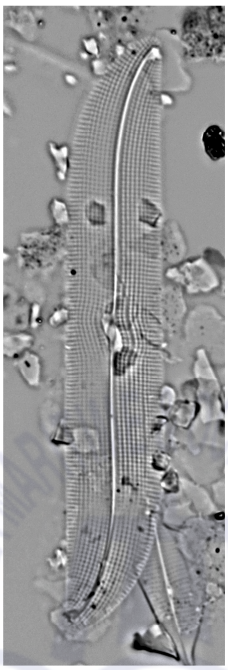

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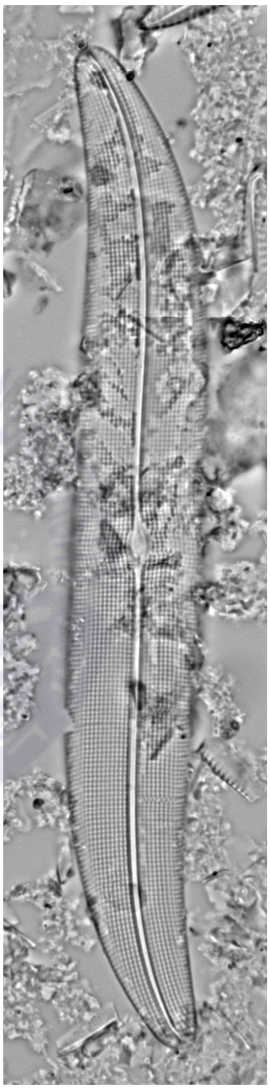

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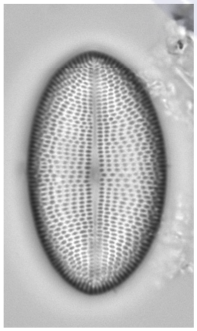

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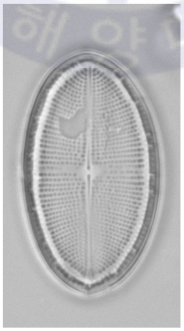

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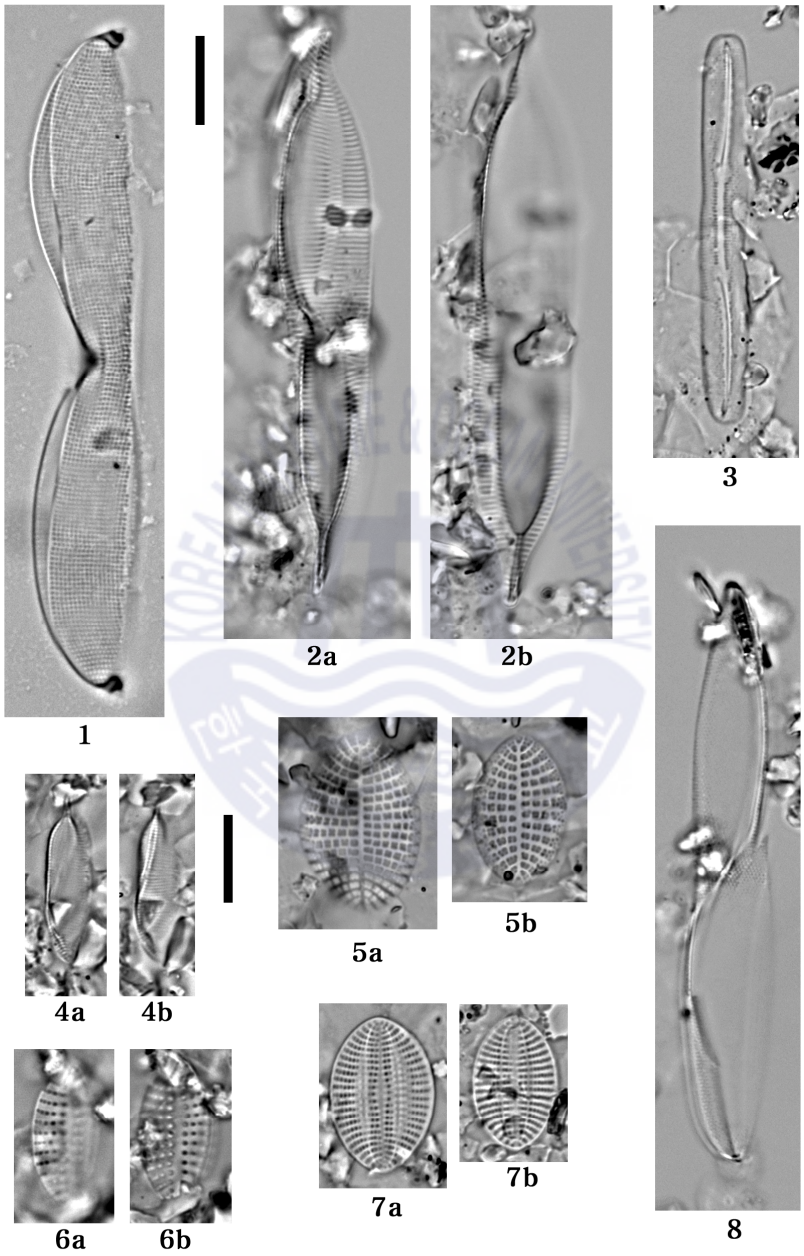

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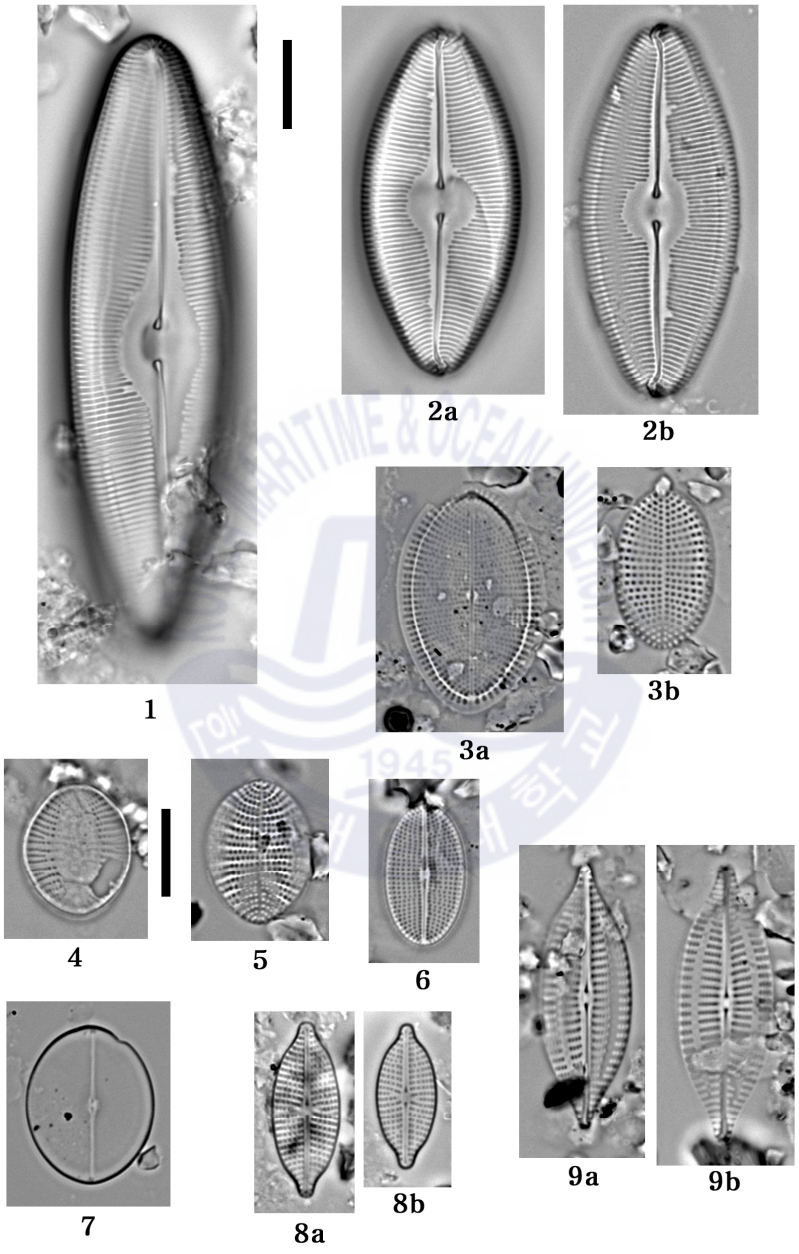

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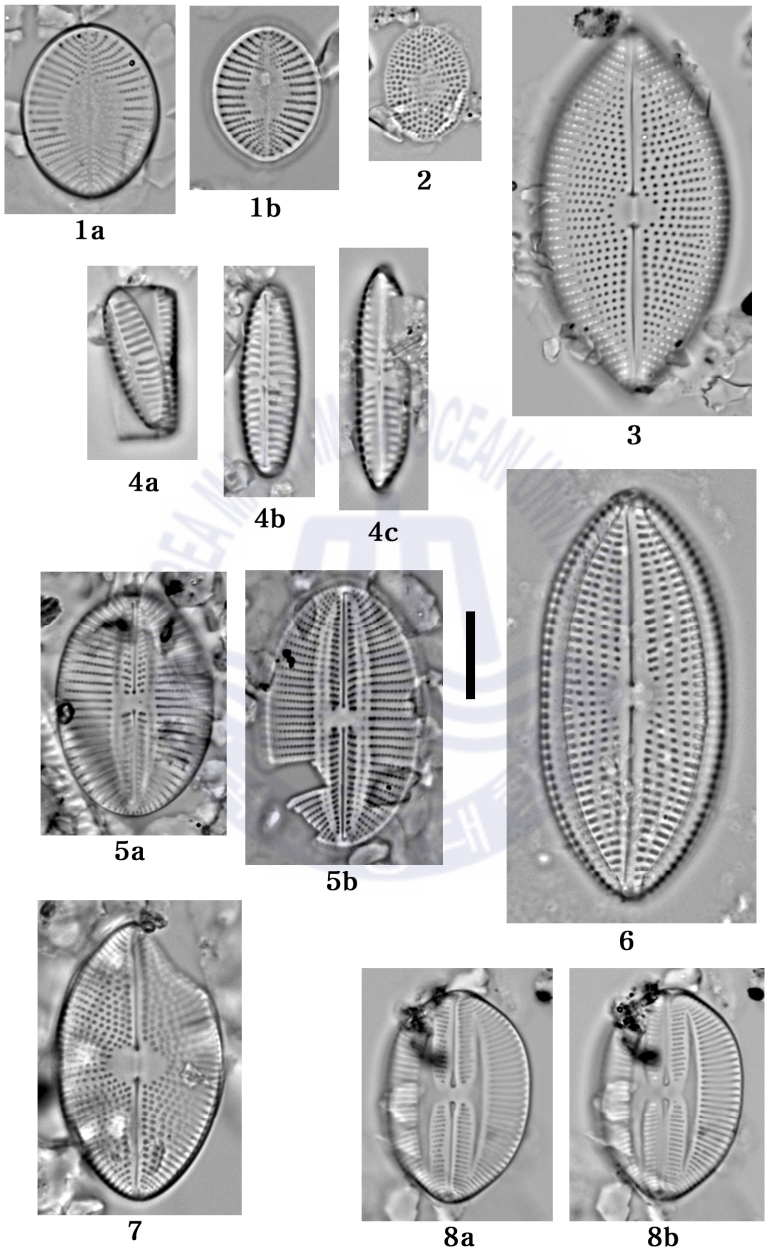

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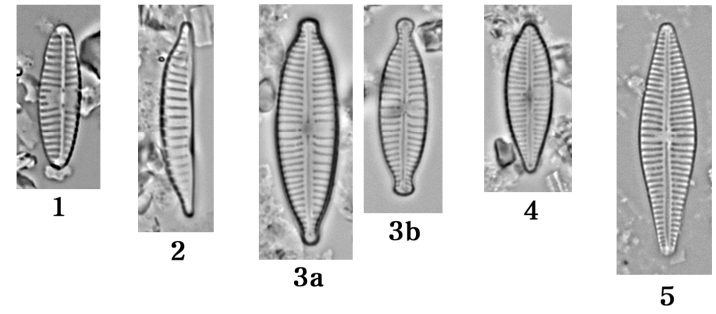
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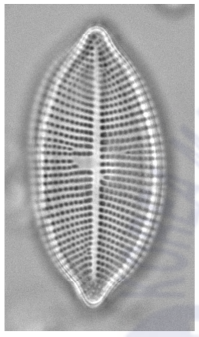
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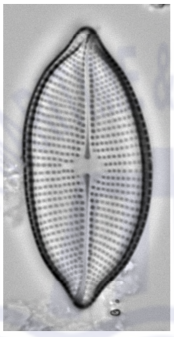
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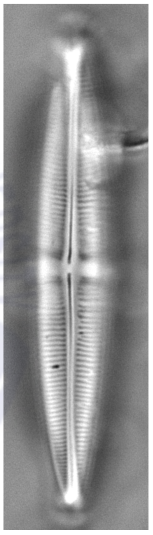
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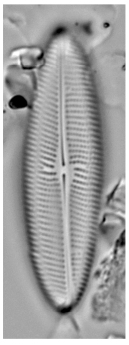
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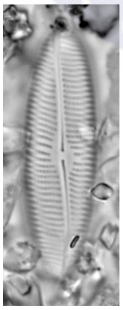
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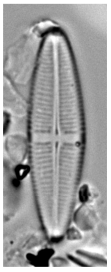
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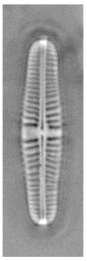
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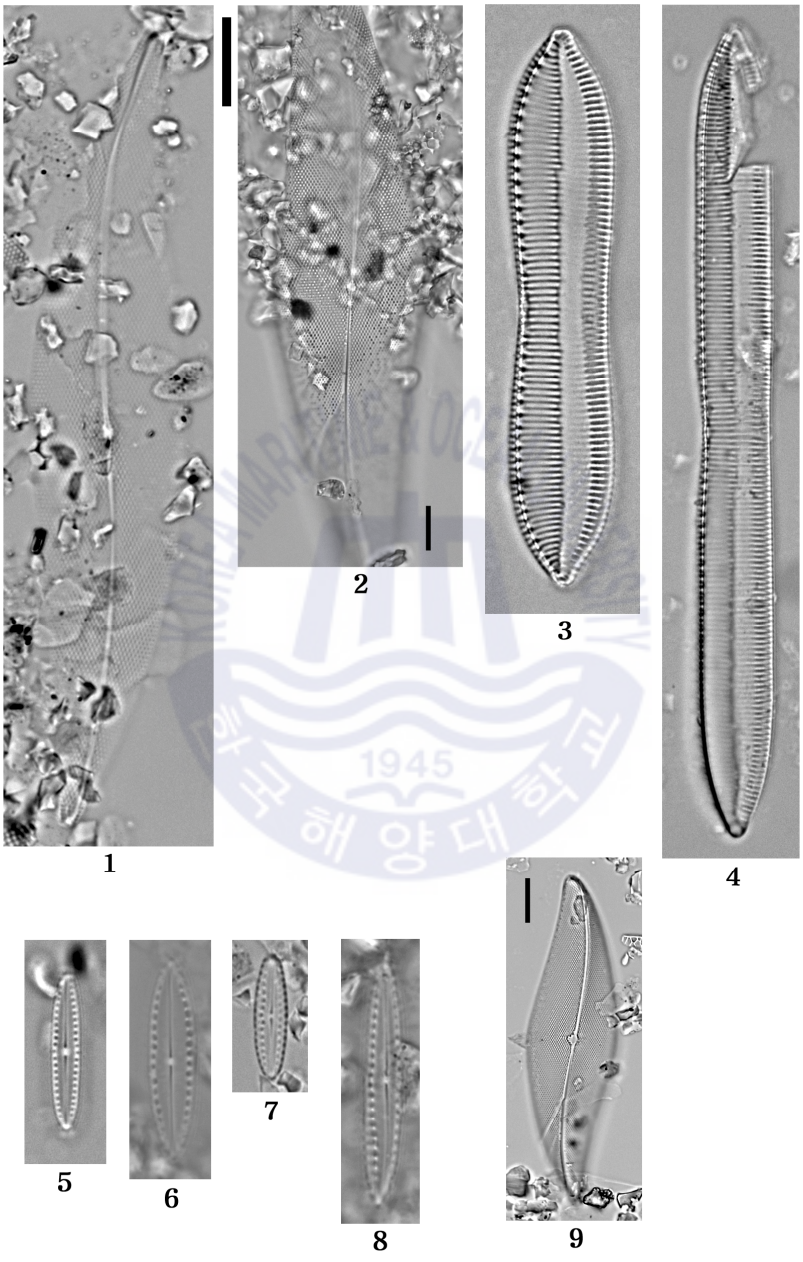

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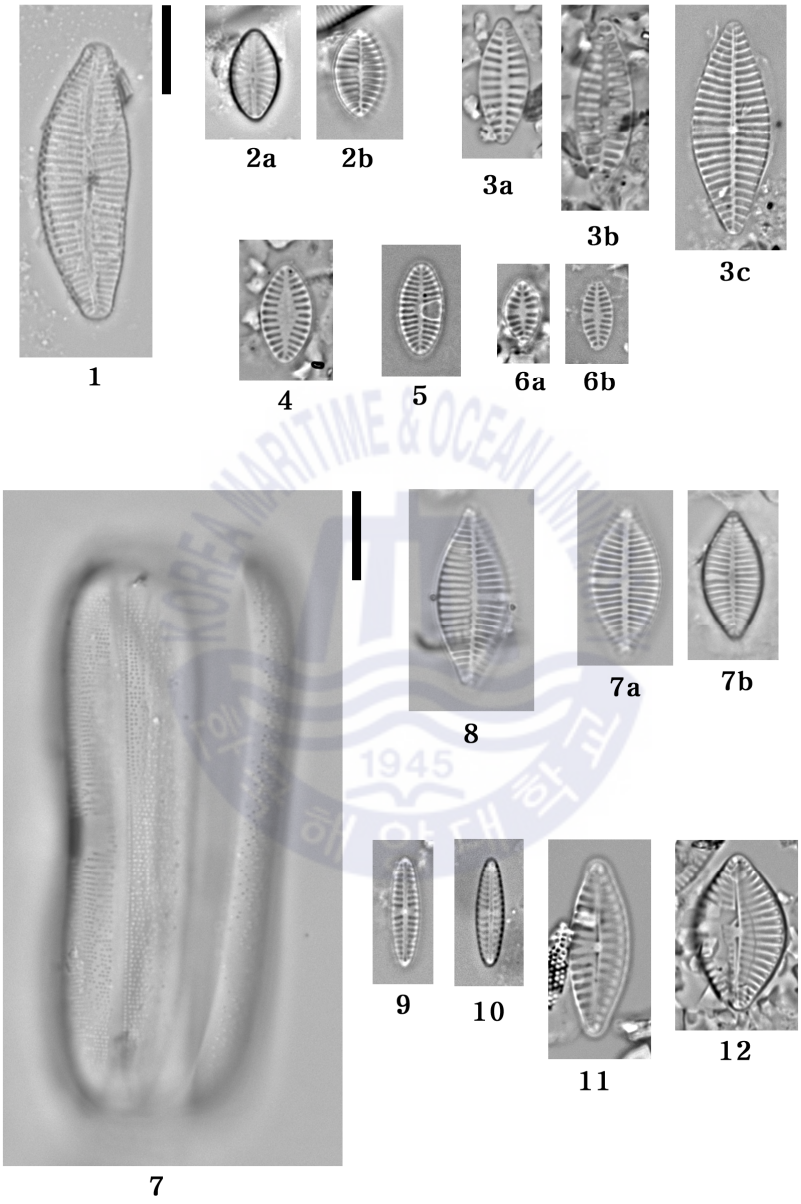

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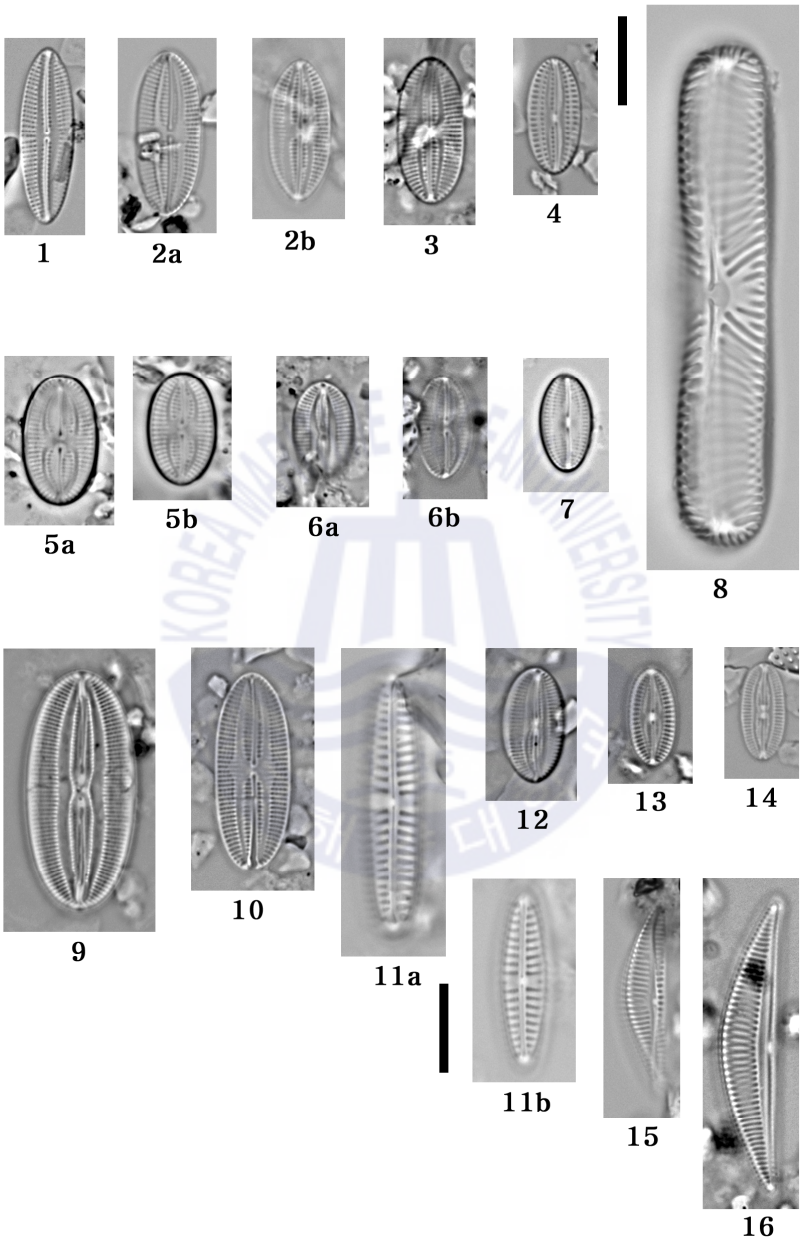

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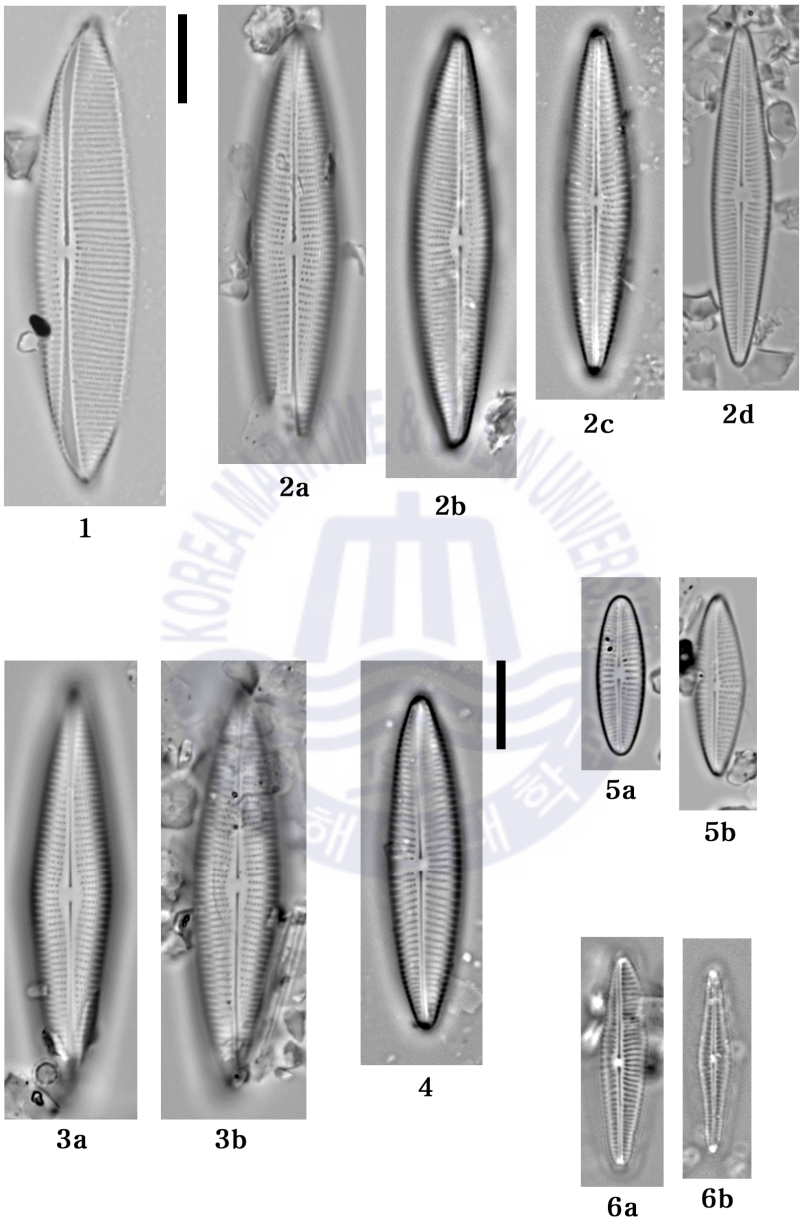

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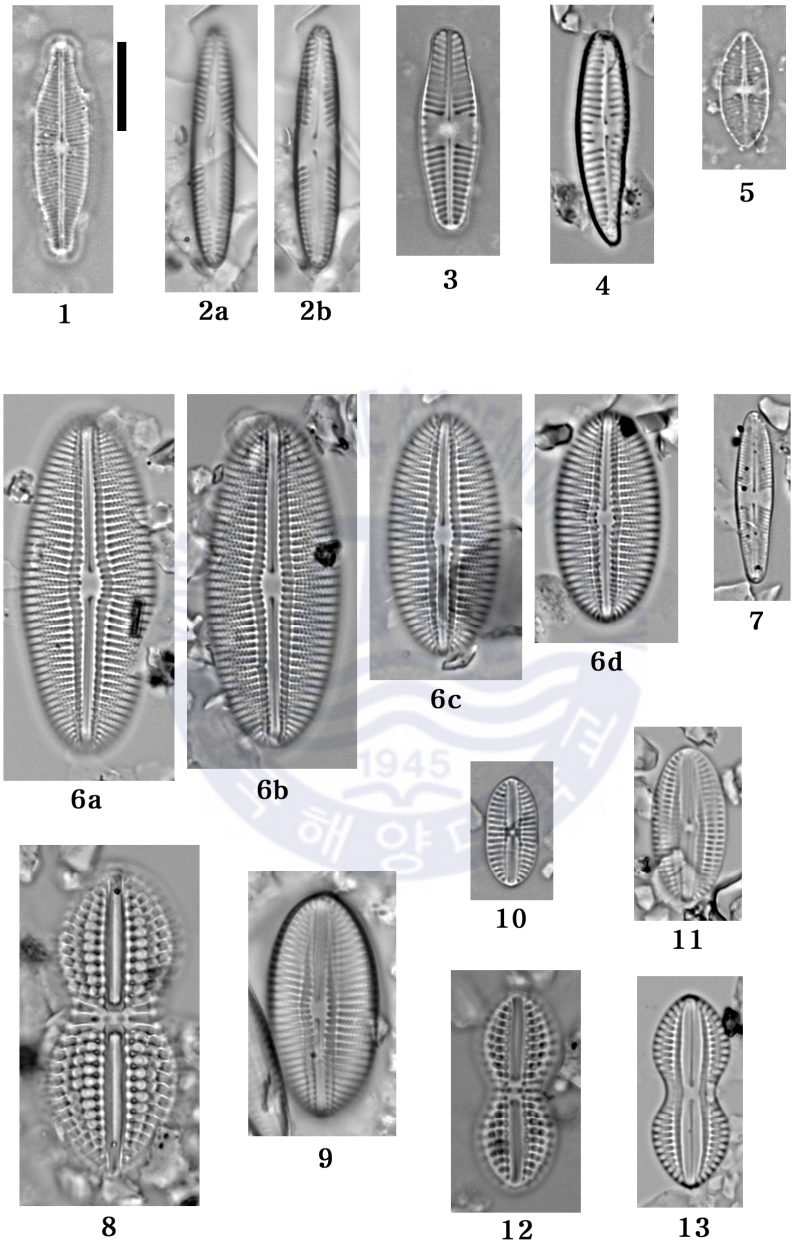

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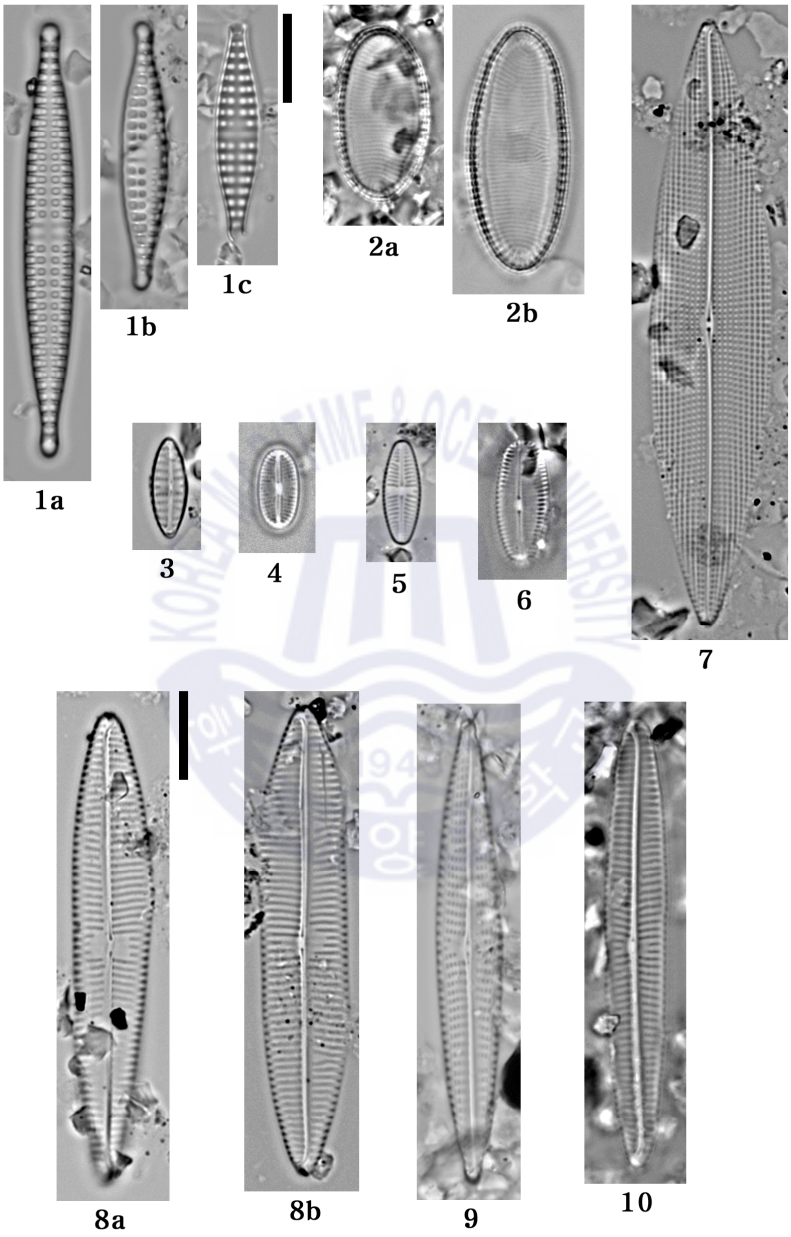

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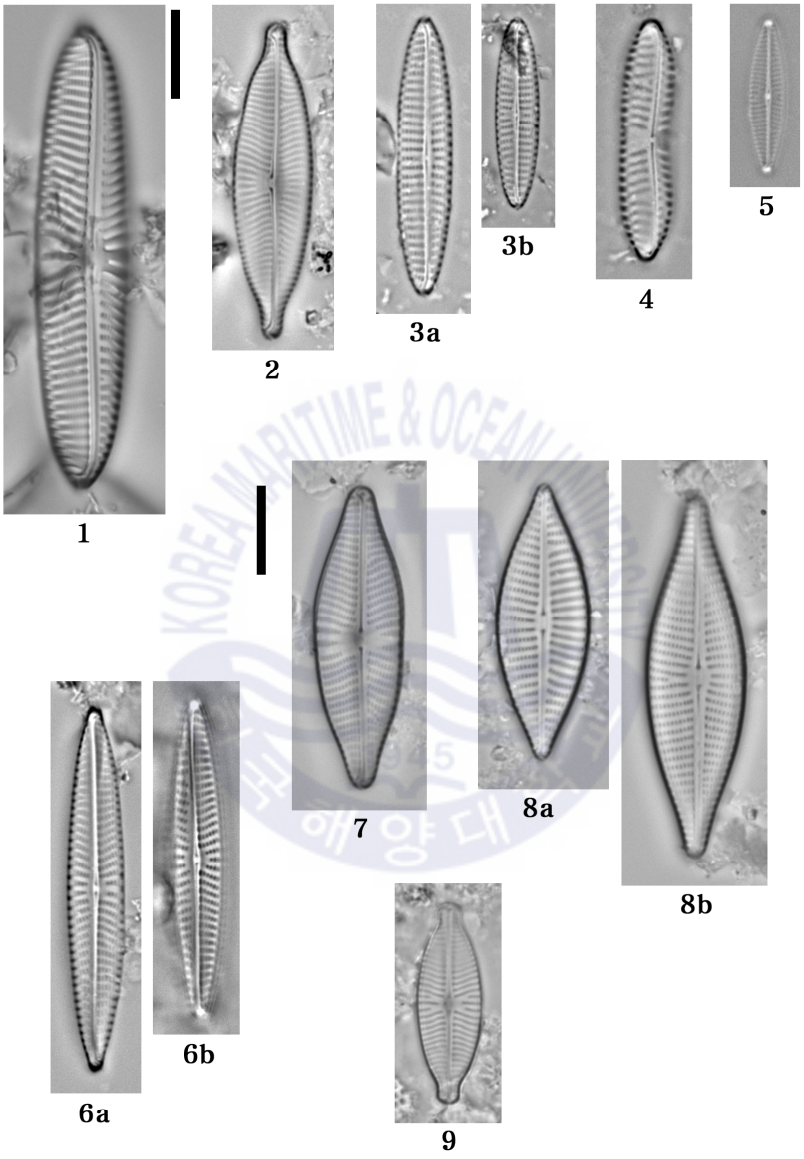

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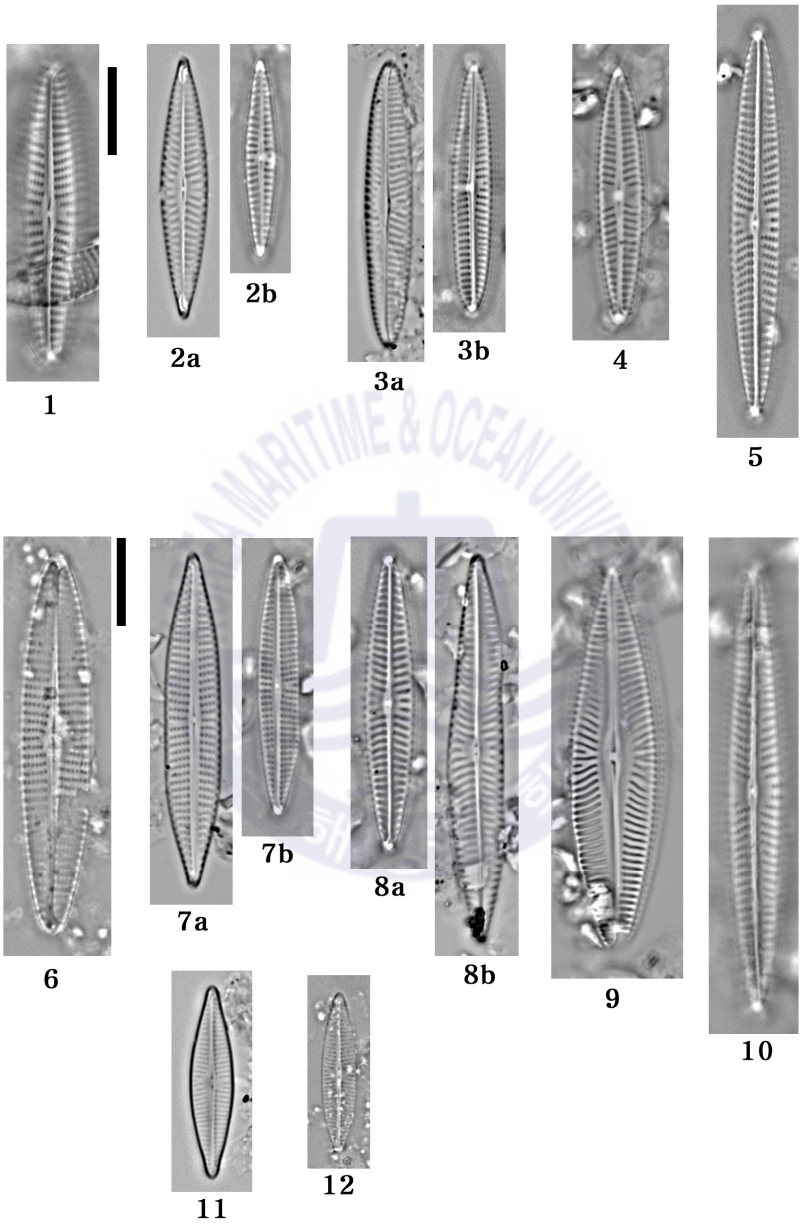

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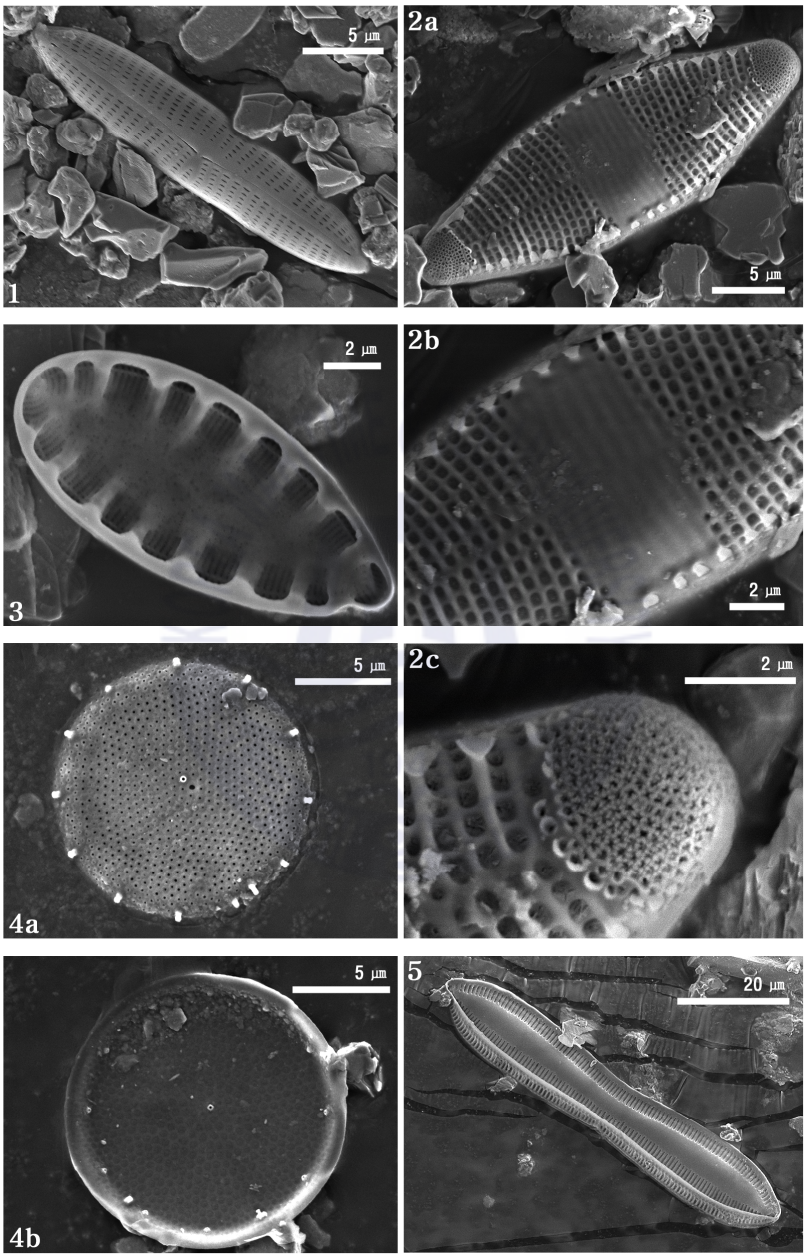

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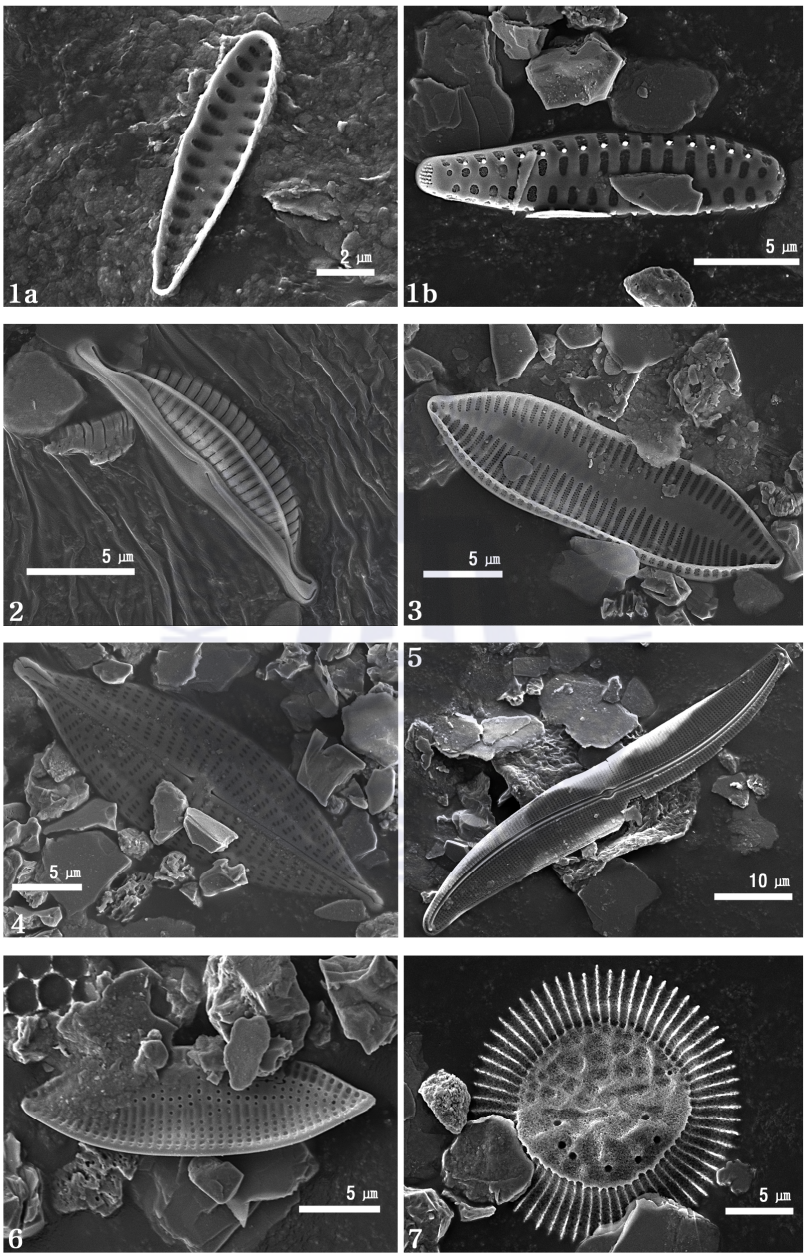

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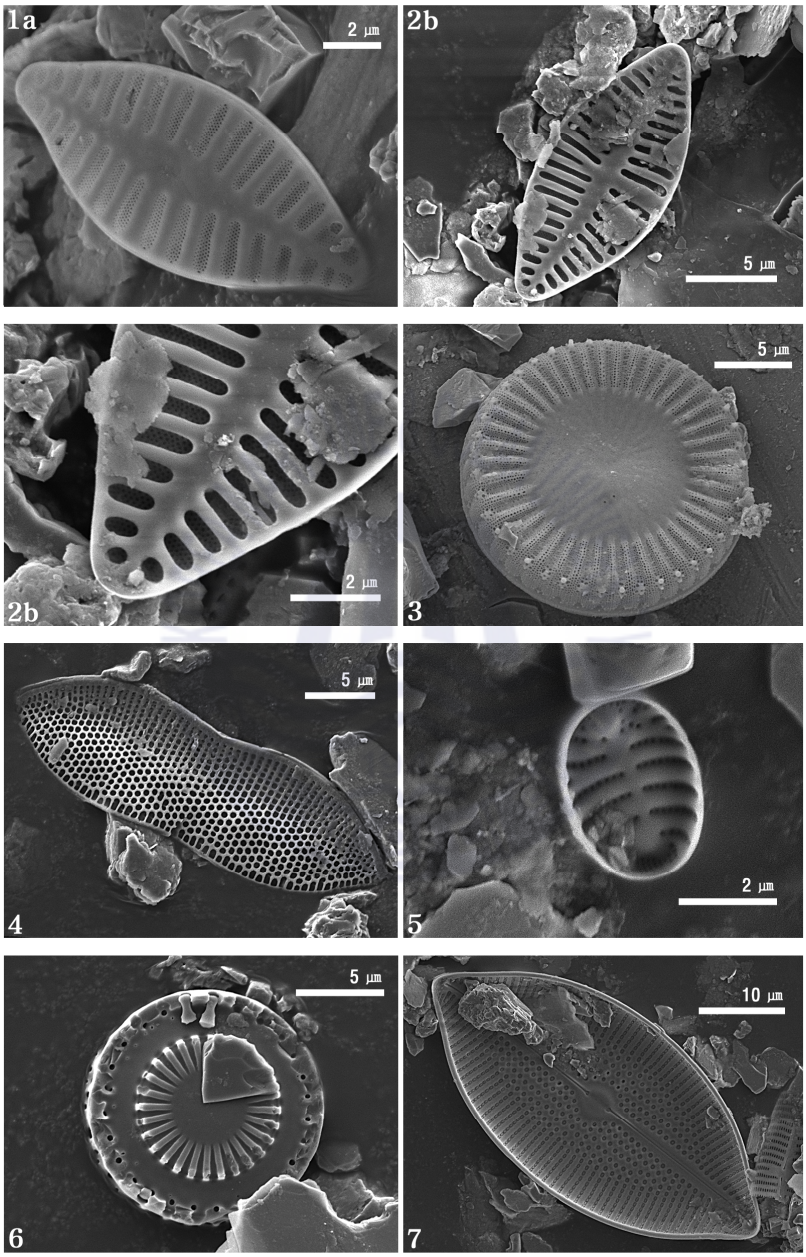

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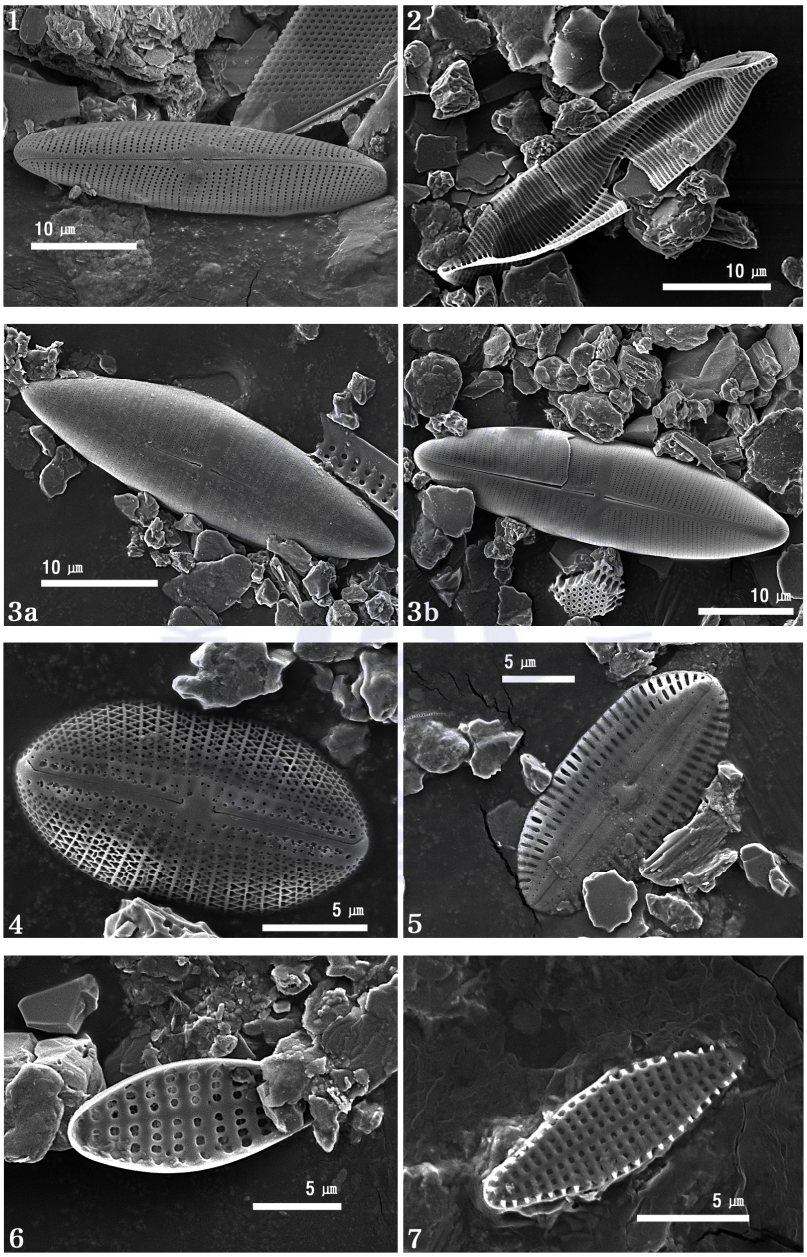

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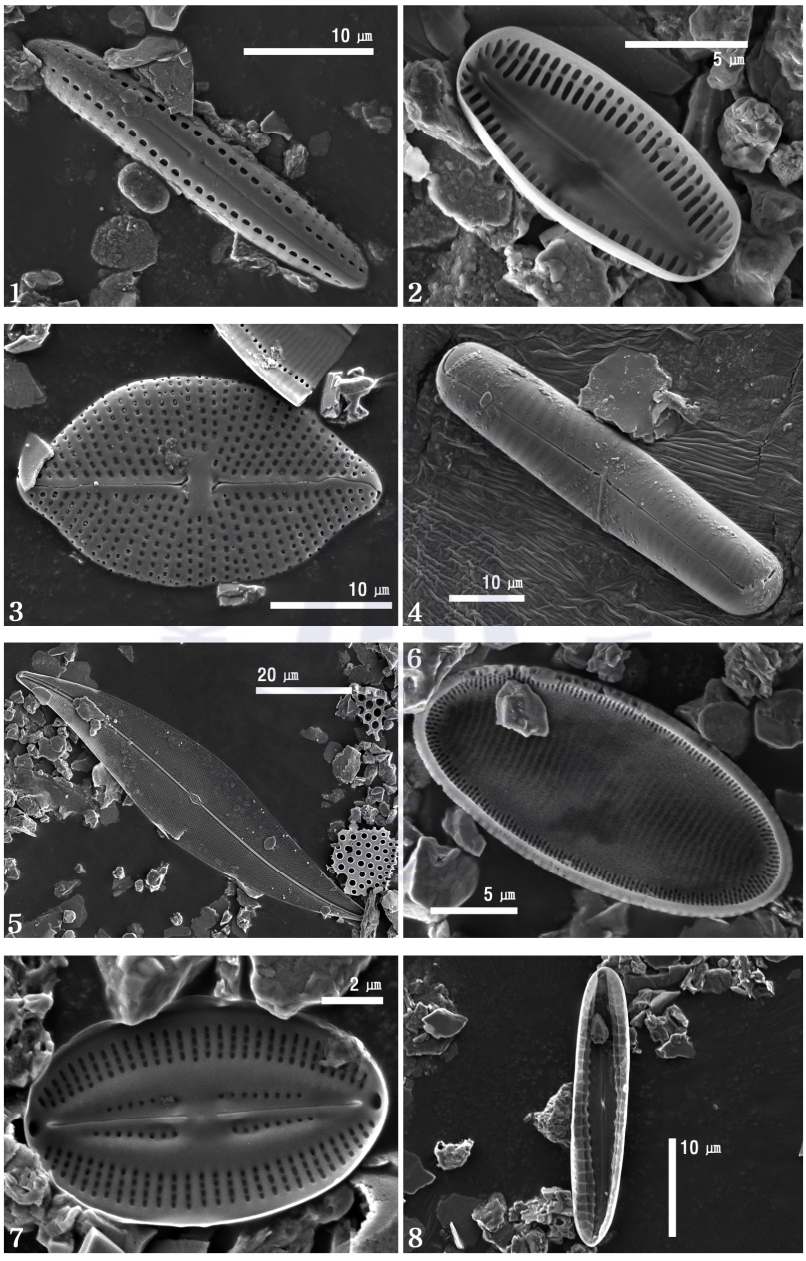

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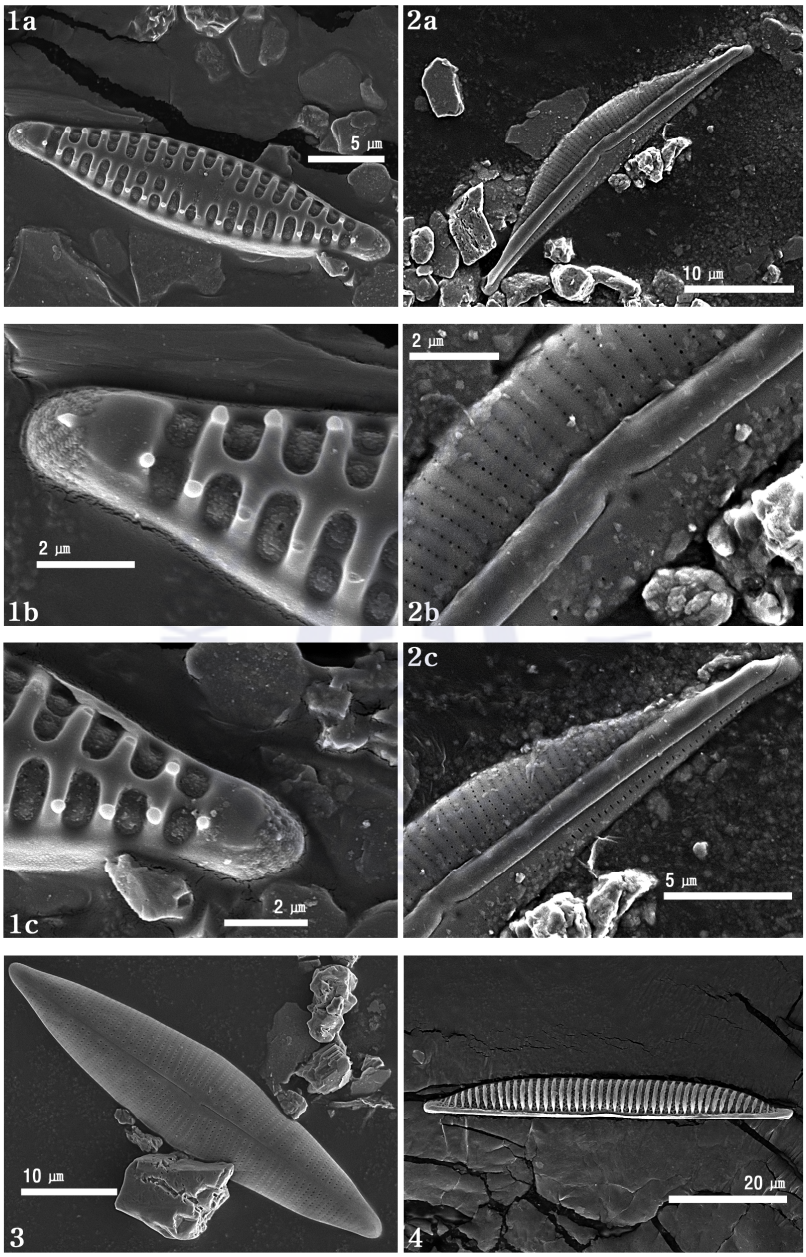

APPENDIX II 색인

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감사의 글

이 논문이 나오기 까지 많은 분들께 도움을 받았습니다. 이렇게 짧은 감사의 글로 담기에는 부족하지만, 짧게나마 적어봅니다.

먼저, 일면식도 없었던 저를 공부할 수 있도록 받아주시고, 지난 2년 동안 이끌어 주신 지도교수님인 박진순 교수님께 진심으로 감사드립니다. 아직도 많이 부족하지만, 열심히 공부하겠습니다.

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